Foreword

Purpose of the IIT Graduate Bulletin

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

The programs described in this bulletin are applicable to those students who enter Illinois Institute of Technology (IIT) in the academic years 2012-2013 and 2013-2014. 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 advisor from the student's major department is the best source for current curriculum information. Updates are also listed on **www.iit.edu/graduate_college/**. The graduate dean's office 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 IIT community.

To this end, IIT 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, IIT 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 IIT community: faculty, staff, and student, is expected to cooperate fully in meeting these goals.

Any student, applicant, or employee of Illinois Institute of Technology who believes that he or she has received inequitable treatment because of discrimination violating IIT'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.

Published by Illinois Institute of Technology, Graduate College, 3300 S. Federal St., Chicago, IL 60616-3793, www.iit.edu.

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ITT Academic Calendar for Fall		TEN	TATIVE*
	2012	2013	2014
Fall Classes Begin	Aug 20	Aug 19	Aug 18
Last Day to Add/Drop with 100% Tuition Refund	Aug 31	Aug 30	Aug 29
Labor Day – No Classes	Sept 03	Sept 02	Sept 01
Fall Degree Conferral Applications Due	Sept 10	Sept 09	Sept 08
Homecoming Weekend	Sept 22	Sept 28	Sept 27
Spring & Summer Incomplete Grades Due	Oct 01	Sept 30	Sept 29
Fall Break Day	Oct 08	Oct 07	Oct 06
Midterm Grades Due	Oct 19	Oct 18	Oct 17
Spring & Summer Class Schedule Published	Oct 22	Oct 21	Oct 20
Last Day to Withdraw	Oct 29	Oct 28	Oct 27
Spring Registration Begins	Nov 05	Nov 04	Nov 03
Thanksgiving Break Begins	Nov 21	Nov 27	Nov 26
Last Day of Fall Classes	Dec 01	Nov 30	Nov 29
Final Exams Begin	Dec 03	Dec 02	Dec 01
Final Grades Due at Noon	Dec 12	Dec 11	Dec 10
Fall Degree Conferral Date	Dec 15	Dec 14	Dec 13

IIT Academic Calendar for Fall

IIT Academic Calendar for Spring

TENTATIVE* 2014 $\mathbf{2013}$ 2015Jan 13 Spring Classes Begin Jan 14 Jan 12 Martin Luther King Day - No Classes Jan 21 Jan 20 Jan 19 Jan 25 Jan 24 Jan 23 Last Day to Add/Drop with 100% Tuition Refund Feb03Feb02Feb 04 Spring Degree Conferral Applications Due Fall Incomplete Grades Due Feb 25Feb 24Feb 23March 01 March 01 March 01 Commencement RSVPs Due Midterm Grades Due March 15March 14 March 13March 18 March 17 March 16 Spring Break Week Begins Fall Class Schedule Published March 25 March 24 March 23March 31 March 30 April 01 Last Day to Withdraw April 07 April 06 April 08 Summer & Fall Registration Begins Graduate Salute Days Begins April 22 April 28 April 27 May 04 May 03 May 02 Last Day of Spring Classes May 06May 05May 04 Final Exams Begin May 14 May 13 May 15Final Grades Due at Noon May 18 May 17 May 16 Spring Degree Conferral Date

* Dates subject to change. See **registrar.iit.edu** for current information.

III Academic Calendar for Summer			TATIVE*
	2013	2014	2015
Session $A \& D$ Classes Begin	May 20	May 19	May 18
Memorial Day – No Classes	May 27	May 26	May 25
Session A Last Day to Add/Drop with 100% Tuition Refund	May 29	May 28	May 27
Session D Last Day to Add/Drop with 100% Tuition Refund	May 29	May 28	May 27
Summer Combined Session Degree Conferral Applications Due	May 31	May 30	May 29
Session B Classes Begin	June 03	June 02	June 01
Session A Midterm Grades Due	June 07	June 06	June 05
Session B Last Day to Add/Drop with 100% Tuition Refund	June 12	June 11	June 10
Session A Last Day to Withdraw	June 15	June 14	June 13
Session $B \& D$ Midterm Grades Due	June 28	June 27	June 26
Session A Last Day of Classes/Exams	June 29	June 28	June 27
Independence Day – No Classes	July 04	July 04	July 03
Session C Classes Begin	July 02	July 01	June 30
Session A Final Grades Due at Noon	July 03	July 02	July 01
Session B Last Day to Withdraw	July 06	July 05	July 04
Session C Last Day to Add/Drop with %100 Tuition Refund	July 06	July 05	July 04
Session D Last Day to Withdraw	July 13	July 12	July 11
Session C Midterm Grades Due	July 19	July 18	July 17
Session C Last Day to Withdraw	July 27	July 26	July 25
Session B Last Day of Classes/Exams	July 27	July 26	July 25
Session B Final Grades Due at Noon	July 31	July 30	July 29
Session $C \& D$ Last Day of Classes/Exams	Aug 10	Aug 09	Aug 08
Session $C \& D$ Final Grades Due at Noon	Aug 14	Aug 13	Aug 12
Summer Combined Session Degree Conferral	Aug 17	Aug 16	Aug 15

IIT Academic Calendar for Summer

* Dates subject to change. See ${\bf registrar.iit.edu}$ for current information.

Objective of Education at IIT

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.

Accreditation

IIT is accredited by the Higher Learning Commission of the North Central Association of Colleges and Schools. www.ncahlc.org

Specific professional curricula are accredited by the Engineering Accreditation Commission and the Computing Accreditation Commission of the Accreditation Board

The Colleges of Illinois Institute of Technology

Graduate College

Ali Cinar, Dean and Vice Provost for Research 301 Main Building 3300 S. Federal St. Chicago, IL 60616 312.567.3024 www.iit.edu/graduate_college/

The Graduate College coordinates the programs of advanced study offered by the academic units of the University. The College consists of the following offices: Office of the Dean and Vice Provost for Research; Office of Sponsored Research and Programs; Office of Research Compliance and Proposal Development; Graduate Enrollment; Graduate Academic Affairs; Office of Graduate

School of Applied Technology

C. Robert Carlson, Dean Daniel F. and Ada L. Rice Campus 201 East Loop Road Wheaton, IL 60187 630.682.6000 www.iit.edu/applied_tech

The School of Applied Technology offers technologyoriented training and education for working professionals. Courses are taught by IIT professors and industry professionals with significant working, teaching, and research experience in their fields. The IIT School of Applied Technology offers education and training in a wide variety of formats including degree, non-degree, certificate, credit, and non-credit programs; corporate training; short courses; and seminars ranging from a few hours to several days in length. Completion of all IIT School of Applied Technology non-credit courses will result in the assignment of Continuing Education Units (CEU) fully accredited by the International Association for Continuing Education and Training (IACET). To strengthen IIT'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.

for Engineering and Technology, American Psychological Association, Council on Rehabilitation Education, American Bar Association, Association of American Law Schools, The Association to Advance Collegiate Schools of Business, and National Architectural Accrediting Board.

Admission; and the Office of Editorial Assistance (Thesis Examiner). The dean chairs the Graduate Studies Committee and the Research Council, sets minimum standards for graduate students, represents the University in national forums for graduate education, and serves as an advocate for promoting graduate education and research across the University.

26 separate Master of Science (M.S.) degrees, which typically include a thesis requirement, are offered. The professional Master's (MAS) degree, which does not require a thesis, has 41 separate offerings. Doctoral degrees (Ph.D.s) are offered in 22 fields.

The IIT School of Applied Technology offers undergraduate degree programs in Information Technology and Management and Industrial Technology and Management; graduate programs in Information Technology and Management, Cyber Forensics and Security, and Industrial Technology and Operations; an undergraduate certificate in Manufacturing Technology and Management; graduate certificates in a variety of topic areas in information technology; Professional Engineer (PE)/ Engineering Intern (EI) Review courses and continuing education courses for Professional Engineers; educational programs for international students with integrated English as a Second Language (ESL) training; and a wide variety of non-credit semester-length and short courses in all disciplines. Through IIT Online, the IIT School of Applied Technology markets and manages online delivery of IIT degree and non-degree educational offerings in all disciplines.

College of Architecture

Wiel Arets, Incoming Dean S.R. Crown Hall 3360 S. State St. Chicago, IL 60616 312.567.3230 www.iit.edu/arch

Armour College of Engineering

Natacha DePaola Carol and Ed Kaplan Armour Dean of Engineering Perlstein Hall, Suite 224 10 W. 33rd St. Chicago, IL 60616 312.567.3009 www.iit.edu/engineering

The IIT 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 90 fulltime faculty, more than 2,500 undergraduate and graduate students, and the graduate and undergraduate programs of five engineering departments.

Chicago-Kent College of Law

Harold J. Krent, Dean Downtown Campus 565 West Adams Street Chicago, IL 60661 312.906.5000 www.kentlaw.edu

Chicago-Kent College of Law is the second oldest law school in Illinois. When it joined the University in 1969, The program in architecture was established at Armour Institute of Technology, one of IIT'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.

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

The mission of the 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.

IIT 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 IIT Stuart School of Business and the University of Illinois-Chicago.

Institute of Design

Patrick F. Whitney, Dean 350 N. LaSalle St., Fourth Floor Chicago, IL 60610 312.595.4900 www.id.iit.edu

Since its founding as the New Bauhaus in 1937, the IIT Institute of Design has grown into the largest fulltime graduate-only design program in the U.S. with over 150 students from around the world. The school

College of Psychology

M. Ellen Mitchell, Dean 252 Life Sciences Building 3101 S. Dearborn St. Chicago, IL 60616 312.567.3500 www.iit.edu/psych offers professional Master of Design degrees in communication design, interaction design, product design and development, strategic design, systems, thinking, and use research; a dual Master of Design/M.B.A. degree program with the IIT Stuart School of Business; and the Master of Design Methods, a nine-month executive program in design methods for innovation. The Institute of Design also offers a Ph.D. in Design, the country's first such program, created in 1991.

Established in 1995, the College of Psychology is noted for its applied graduate programs in clinical, industrial/organizational, and rehabilitation psychology. It offers an undergraduate program that is focused on psychology as a science linked to the professions. The Bachelor of Science degree in Psychology has three optional specialty tracks from which to choose: Culture, Conflict, and International Relations; Psychology of Emerging Technologies; and the Human Environment.

College of Science and Letters

R. Russell Betts, Dean
220 Engineering 1 Building
10 W. 32nd St.
Chicago, IL 60616
312.567.3800
www.iit.edu/csl

Stuart School of Business

Harvey Kahalas, Dean IIT Tower 18th Floor 10 W 35th Street Chicago, IL 60616 312.906.6500 www.stuart.iit.edu

IIT Stuart School of Business provides intellectually rigorous business and management education at all levels, from baccalaureate to doctoral. All IIT Stuart programs are designed to educate tomorrow's global innovators through the unique concept of strategic competitiveness. Constructs including creativity, innovation, entrepreneurship, incisive decision-making, leadership, and sustainability are interwoven throughout coursework and professional development opportunities, offering students thorough preparation for the challenges of the Next Economy. The College of Science and Letters traces its roots to the Lewis Institute, founded in 1895. The Lewis Institute joined with Armour Institute of Technology in 1940 to form the current Illinois Institute of Technology. The College of Science and Letters offers some 50 academic specializations in seven departments: Applied Mathematics; Biological and Chemical Sciences; Computer Sciences; Humanities; Mathematics and Science Education; Physics; and Social Sciences.

IIT Stuart was established in 1969 with a gift from IIT alumnus and noted financier Harold Leonard Stuart. The school houses the Knapp Entrepreneurship Center, the Center for Financial Markets, the Center for the Management of Medical Technology, the Center for Strategic Competitiveness, and the Center for Sustainable Enterprise.

IIT Stuart offers the following degrees: B.S. in Business Administration, B.S. in Business Administration and Applied Science, M.B.A, Masters of Mathematical Finance (M.M.F.), M.S. in Environmental Management and Sustainability, M.S. in Finance, M.S. in Marketing Communication, Master of Public Administration, and Ph.D. in Management Science. A series of dual degrees with IIT's Chicago- Kent College of Law and IIT's Institute of Design are also offered, as well as numerous Graduate Certificate Programs.

IIT History and Campuses

IIT's traditions span more than a century of innovation and educational leadership. IIT came into being in 1940 with the merger of Armour Institute of Technology (founded in 1892) and Lewis Institute (founded in 1896).

Today, the University has several campuses and offers degree programs through the College of Architecture, Armour College of Engineering, Chicago-Kent College of Law, Institute of Design, School of Applied Technology, College of Psychology, College of Science and Letters, and Stuart School of Business.

The 120-acre Main Campus is located three miles south of the central business district in Chicago, and is internationally known for its architecture. The Master Plan of the campus and many of its 50 buildings were developed by Ludwig Mies van der Rohe, one of the 20th century's most influential architects.

IIT's Downtown Campus, at 565 W. Adams St., in the West Loop business district, houses the Chicago-Kent College of Law and the Stuart School of Business. A shuttle bus provides transportation between the Main and Downtown campuses.

The Institute of Design, 350 N. LaSalle St., is in an outstanding downtown location and state-of-the-art facility.

The Daniel F. and Ada L. Rice Campus, at 201 E. Loop Road in Wheaton, IL, is IIT's west-suburban location. Graduate and upper-division undergraduate courses and degree programs are available at the Rice Campus with

Chicago and its Environs

Chicago is world-renowned for its museums and architecture, and offers exceptional career and internship opportunities in all of IIT'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. evening and Saturday classes and via courses broadcast live through IIT Online.

The School of Applied Technology offers degree programs in information technology and management, industrial technology and management, non-credit short courses, and information technology training programs.

IIT was one of the first institutions in the Chicago area to offer distance education by delivering live course lectures to remote students via microwave as early as 1977. Over the years, IITV delivered countless hours of courses and programming to as many as 72 corporate and non-corporate locations, such as Motorola and Argonne National Laboratory. IITV became IIT Online and continues that strong tradition of televised delivery with video lecture capture, as the distinctive hallmark of an IIT Online course delivered over the internet. Through IIT Online, academic departments now offer 28 distance education degree and certificate programs to the IIT community around the world.

The Moffett Campus, in southwest-suburban Summit-Argo, IL, houses the Institute of Food Safety and Health (IFSH), a multidisciplinary food safety operation facility, which is funded by the U.S. Food and Drug Administration and supported by the food industry. Established with a gift from CPC International, Inc., the campus has enabled the University to develop academic programs in food safety and technology. Courses leading to Master's degrees and certificate programs in food safety and technology and in food process engineering are offered at this facility.

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.

Enrollment (Fall 2011)		Student Demographics		Degrees Awarded 2010-2011	
Undergraduate	2714 students	Male	63%	Bachelor	545
Graduate	3999 students	Female	37%	Master	1487
Law	$1074 \; students$	Minority*	17%	First Professional	332
Total	7787 students	International	43%	Ph.D.	80
		Countries of Origin	100	Total	2444
		Student/Faculty Ratio	11:1		

A Snapshot of the IIT Community

 \ast Includes African American, Asian American, Hispanic American, and Native American

Academic Resource Center

www.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 and the sciences on a drop-in basis and by appointment.

Undergraduate and graduate peer tutors are available during the fall, spring, and summer semesters. In addition to peer tutoring, the ARC also offers exam reviews, workshops, supplemental instruction, group study space,

Access, Card, and Parking Services

www.harkcard.iit.edu or www.parking.iit.edu

The Access, Card, and Parking Services Office issues HawkCards and parking permits for the University. The HawkCard is the picture identification card for IIT students, staff, and faculty. Not only does it serve as an ID, it also grants access to buildings, parking lots, computer labs, Keating Athletic Center, the shuttle bus, library

Athletics and Recreation

www.illinoistechathletics.com

The Department of Athletics offers a comprehensive program of varsity sports, intramural competition, instruc-

Athletics

The Scarlet Hawks men's varsity teams compete in intercollegiate baseball, cross-country, soccer, swimming and diving, indoor track and field, and outdoor track and field. Women's varsity teams compete in cross-country,

Recreation

The Intramurals and Recreation program offers a variety of fun, recreational, social, and competitive activities for IIT students regardless of experience and ability. Traditional offerings include basketball, volleyball, flag football, dodgeball, soccer, and softball. Other sports include, racquetball, badminton, cricket, kickball, and ultimate frisbee. Fitness classes are also available for students including, but not limited to yoga, Zumba, Salsa and an OTS computer laboratory including PCs and Macs. The ARC also keeps textbooks, e-textbooks, and iPads with academic apps for your reference.

The ARC is located in the northwest corner of the Hermann Hall Building, Room 112. The ARC is open Monday through Thursday, 10:00 a.m. to 8:00 p.m., Friday, 10:00 a.m. to 3:00 p.m., and Sunday from 6:00 p.m. to 9:00 p.m. For more details, visit the ARC website: www.iit.edu/arc or call 312.567.5216.

materials' check-out services, and TechCash balances. Permits to park in IIT lots are available for purchase on an annual, academic year, or monthly basis. Students should visit Access, Card, and Parking Services in Hermann Hall, Room 201, for more information, or visit www.hawkcard.iit.edu or www.parking.iit.edu.

tion, and formal recreation activities for both men and women.

swimming and diving, soccer, volleyball, indoor track and field, and outdoor track and field. The University is a member of the National Association of Intercollegiate Athletics (NAIA).

dancing, and Pilates. In addition, we offer open recreational play in basketball and volleyball along with open swimming in the Keating Sports Center pool. Moreover, IIT has the only disc golf course in Chicago proper, which gives students another recreational outlet and makes our university a popular destination for local area disc golf enthusiasts.

Campus Life

www.iit.edu/campus_life

The Office of Campus Life provides campus programs and events designed to enhance the student educational experience outside of the classroom. Campus Life manages the campus Orientation Program, Freshman Year Experience (FYE) programming, and provides direct

Career Management Center

www.cmc.iit.edu

Located in Herman Hall, the Career Management Center (CMC) offers individual career advising and testing, résumé critiques, job search strategies, mock interviews, and labor market and salary data. The CMC also administers the Cooperative Education Program and the Internship Program, whereby qualified students gain experience in their field of study prior to graduation. Both programs are options for domestic and international students at the undergraduate or graduate level. oversight to more than 100 student organizations, including the Student Government Association and Union Board. Other registered student organizations represent a variety of student interests in areas such as culture, recreation, academics, and the arts.

The CMC conducts a variety of professional development workshops on topics including résumé and cover letter writing, job search strategies, communications, and interviewing skills. The CMC also hosts biannual career fairs, employer spotlights, and on-campus interviews. Career related resources, workshop schedules, and a link to job postings may be accessed by students and alumni registered in NACElink (**www.cmc.iit.edu**). Individual sessions with a career counselor may be scheduled by appointment at 312.567.6800.

Communication Across the Curriculum Program

www.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 (**www.iit.edu/cac**) and through the IIT Writing Center (see page 23), located in Siegel Hall 232/233/234, the CAC provides assistance in communication skills for academic inquiry, professional research, and the workplace. The CAC also assists IIT

Commuter Student Services

IIT's commuter student organization, Commuter Students 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 instructors in developing materials relevant to written, oral, electronic, and interpersonal communication in discipline-specific courses – particularly Introduction to the Profession (ITP), communication-intensive courses (C-Courses), and Interprofessional Projects (IPROs). The CAC director also administers IIT's Basic Writing Proficiency requirement.

and activities throughout the year. For more information on CSA's programming, students should consult the Office of Student Activities in the McCormick Tribune Campus Center.

Cooperative Education Program

www.cmc.iit.edu 312.567.6800

Cooperative education is a learning approach that integrates college studies with professional work experience in industry, business, or government. Salaries among IIT co-op students are competitive and help defray educational expenses. The co-op experience improves employment opportunities upon graduation. Full-time IIT students must meet the co-op and intership eligibility requirements at IIT and maintain at least a

Part-Time Employment www.iit.edu/financial_aid/student_employment

Part-time employment opportunities may be available for students both on and off campus. Positions may be career related co-ops or internships, non-Federal Work Study jobs, part-time, or seasonal work. Coops, internships, and on campus jobs are posted in the Career Management Center (CMC) NACElink database. Federal Work Study positions and information can be found on the Financial Aid webiste www.iit.edu/financial_aid/student_employment.

Students interested in and eligible for employment off campus in their field of study may get job search assistance from the CMC and must attend an Introduction

Disability Resources

Services for persons with disabilities are coordinated by the Center for Disability Resources. Persons with disabilities who are interested in applying for admission to any of IIT's education programs are invited to call the center or to email disabilities@iit.edu prior to their arrival 2.50 GPA. Students with a GPA lower than 2.50 may participate only with the permission of the vice provost for undergraduate affairs. Email **ugaa@iit.edu** for more information.

Interested students must attend an Introduction to Cooperative Education and Internship Workshop conducted by the CMC.

to Cooperative Education and Internship Workshop conducted by the CMC. Workshop schedules are posted at **www.cmc.iit.edu**. Appointments for individual career counseling may be made by calling 312.567.6800.

International students (on F1 visa) are restricted to oncampus employment for their first academic year of study at any school in the United States. After completing one academic year in the country, students on an F1 visa may be eligible for opportunities off campus (only if related to their field of study) through the Cooperative Education Program or the Internship Program.

on campus to discuss their individual needs. Enrolled students with disabilities are encouraged to contact the director of the Center for Disability Resources to register and request accomodations.

Idea Shop ipro.iit.edu/ideashop

A catalyst for innovation, the Idea Shop is a 13,000square-foot facility composed of a state-of-the-art 3D rapid prototyping lab, a Dell laptop lab, an iPad library, an iMac lab for mobile app development and video editing, collaborative teaming areas, formal classrooms, and flexible open spaces. The Idea Shop is home to IIT's Interprofessional Projects Program (IPRO), entrepreneurship initiatives, and the Exelon Summer Insitute, an accelerated program for incoming first-year students. The Idea Shop is located in the University Technology Park at IIT, a newly remodeled incubator space for researchers and companies requiring robust infrastructure.

The Idea Shop helps to build the competency and professional perspectives of IIT students at all levels. It is an inviting place for returning alumni, students, and prospective students to interact and participate in workshops. The Idea Shop also serves the Chicago-area entrepreneurial community and facilitates the process by transforming student and faculty generated ideas into actual businesses, products, and patents.

International Center

www.ic.iit.edu

The purpose of the International Center is to promote international education and cultural exchange by (1) supporting international students, faculty, staff, and students studying abroad, (2) assisting in the compliance of immigration and other related regulations, (3) providing study abroad advising for students interested in studying in another country, and (4) providing services and resources to the IIT community. These services include: individual and group orientations to the University and community; assistance with document preparation for employment and other related non-immigrant benefits; workshops for faculty, staff, and students on issues affecting international students and scholars; cross-cultural activities and programs that promote intercultural perspectives and address adjustment issues; study abroad advising for students interested in studying in another country.

All international students, scholars, and faculty are required to report to the International Center immediately upon arrival.

Interprofessional Projects

The Interprofessional Projects (IPRO) Program coordinates the IPRO course, a general education requirement for all undergraduates and a possible elective for graduate students. The IPRO course organizes students in semester-long multidisciplinary project team sections based on contemporary problem-solving challenges that are proposed by students, faculty members and sponsoring organizations that reflect the diversity of the workplace: corporations, entrepreneurial ventures, nonprofit organizations and government agencies. The IPRO teams are self-directed, offering terrific opportunities for developing leadership potential and collaborating on interesting technical, business and social challenges with faculty and sponsor mentors. Entrepreneurial IPRO (En-PRO) teams address the added challenge of developing a

IIT Online

IIT was one of the first universities in the Chicago area to offer microwave delivery of live courses to area companies. As early as 1977, IIT was delivering course lectures to remote students and over the years, IITV - as IIT Online was then known - delivered countless hours of courses and programming to as many as 72 corporate and non-corporate locations. IIT Online continues that strong tradition of televised delivery - video lecture capture is the distinctive hallmark of an IIT Online course.

IIT Online currently delivers over 9000 course lectures per year in formats from interactive video conference to on-demand internet access. That represents over 400 hundred courses from almost every academic department. Through IIT Online, IIT offers 28 distance learning programs and certificates, the bulk of which can be completed 100% online. IIT Online supports these courses with:

- Student services staff coordinate room scheduling, exams, proctors, exam & homework return, as well as troubleshoot technical issues like video playback, etc.
- Production student technical directors are used for every class session of every course to record faculty instruction and ensure a quality recording; and

technological entrepreneurship opportunity analysis that can lead to a business plan for a new venture concept. IPRO teams may include five to 15 students from all academic levels (sophomore through graduate school), and across IIT's professional programs (applied technology, architecture, business, design, engineering, law, political science, technical communication, psychology, and the sciences). Integrating these perspectives within a project team stimulates student and faculty interaction across the boundaries of individual disciplines and experiences. Learn more and review the current or future course listings by visiting http://ipro.iit.edu or the IPRO Program Office at 3424 South State Street, Central Building, 4th Floor.

• Post production - student editors edit every class session of every course, adding synchronized slides and .pdf files of notes to the final deliverable loaded into a Blackboard shell.

In partnership with faculty and departments, IIT Online delivers internet (asynchronous) and video-conference (synchronous) courses. Most online programs are designed for graduate students and courses follow the same 16-week semester academic calendar as the University. Courses have the same faculty, and follow the same syllabus. If the course uses exams, exams follow the same schedule. Exams are typically administered at local testing centers for students in the United States.

Prospective students who wish to take courses online at Illinois Institute of Technology must first be admitted to a degree, certificate, or professional development program. Individuals are welcome to apply to take courses in a non-degree capacity, but please note that non-degree status does not confer automatic admission into a degree-granting program and limits to the number of overall credits that can be taken.

Students taking IIT Online courses are IIT students and are subject to all of the same policies and procedures as on-campus students in face-to-face courses.

Libraries

library.iit.edu

IIT's libraries include Paul V. Galvin Library; the Center for the Study of Ethics in the Professions (Main Campus); the Graham Resource Center (Main Campus); the Louis W. Biegler Library (Rice Campus); the Downtown

Paul V. Galvin Library library.iit.edu

As the University's central library, Paul V. Galvin Library combines cutting-edge information technology with traditional library services. The library's holdings include more than 1.2 million volumes, including books, journals, government publications, and microforms. Digital services provide 24-hour Internet access to more than 100 online databases indexing millions of journal articles; approximately 40,000 full-text online journals; electronic course reserves; and I-Share, a statewide resource sharing system of 76 academic libraries. Galvin Library also provides web-based delivery of a variety of materials,

Graham Resource Center library.iit.edu/grc

Housed in Crown Hall, the Graham Resource Center (GRC) is IIT's architecture library, serving students and faculty of the College of Architecture (COA), and a branch of Paul V. Galvin Library. The GRC supports the educational and curricular goals of the COA by acquiring, preserving, and serving materials in various media to COA students, faculty, and staff; providing reference and research assistance to patrons about architecture, landscape architecture, and city planning, and offering bibliographic instruction to all GRC and architecture researchers and users.

Louis W. Biegler Library library.iit.edu/biegler

The Louis W. Biegler Library, a branch located at the Rice Campus in Wheaton, provides access to a circulating collection, reserve materials, and journals, as well as access to digital resources. Services for distance learners are coordinated at Biegler, and include interlibrary loan,

Center for the Study of Ethics in the Professions ethics.iit.edu

The Center, located in Hermann Hall, contains a variety of materials dealing with topics in practical and professional ethics, such as autonomy, confidentiality, conflict of interest, and self regulation. The library provides Campus Library, serving the Chicago-Kent College of Law and the Stuart School of Business; the Institute for Food Safety and Health Library (Moffett Campus); and the IIT Archives (Main Campus).

including documents requested via interlibrary loan. The library's instruction program serves the IIT community by teaching skills needed to locate, retrieve, and evaluate information. Library instructors teach at all levels from introductory to advanced and cover a broad range of all types of information and retrieval techniques. Library workshops are offered regularly throughout a semester or can be specifically tailored for a course or program by library subject specialists.

Phone number: 312.567.3616

The collections of the Graham Resource Center includes more than 15,000 books, 40 journal titles, and many electronic resources to meet research and reference needs. The GRC also holds special collections focused on Mies van der Rohe and Chicago architecture, as well as a circulating collection of iconic chairs.

Phone number: 312.567.3256

web-based document delivery, research and reference consultations, and library instruction.

Phone number: 630.682.6050

bibliographic assistance to students and researchers and assists visiting scholars and practitioners.

Phone number: 312.567.6913

Downtown Campus Library library.kentlaw.edu

Serving Chicago-Kent College of Law and IIT's graduate Business program, the Downtown Campus Library (DTC) also includes an extensive collection of U.S. Government, United Nations, and European Union documents. The DTC library provides access to digital

Institute for Food Safety and Health Library library.iit.edu/ifsh

Located on IIT's Moffett Campus in Summit, the Institute for Food Safety and Health (IFSH) branch library supports research on food technology and food safety. A depository library for the FAO (Food and Agriculture Organization of the United Nations), the library provides

Multicultural Student Services

Serving as the primary office for students' personal and professional development, OMSS is an ally for domestic students of color, women, LGBT, and other diverse populations. We provide a variety of programs and services that address culture, history, policy, values, and belief systems. Through these programs we promote and celebrate diversity and equality.

All students, faculty, staff, alumni, and friends of the University are welcome to partner with OMSS in advancing its efforts to support diversity. resources, as well as services such as reference, instruction, and interlibrary loan.

Phone number: 312.906.5600

digital access to all of the Galvin Library databases, as well as services such as interlibrary loan, web-based document delivery, and library instruction.

Phone number: 708.563.8163

Some of the support and services our office offers to students:

- Educational & Cultural Programs
- Personal and Professional Development/ Guidance
- Student Networking Events
- Academic Book Loan Program
- Lending Library
- "Voices of Diversity" Newsletter
- Resources on Culture and Diversity
- Minority Scholarship Information
- Cultural Events Calendar (Announcement for offcampus events)
- A Safe Space
- & Always an OPEN door

One Stop

onestop.iit.edu

The One Stop has been established to provide services to students with maximum efficiency and a minimum of confusion. This office, representing the the Offices of the Registrar, Financial Aid, Academic Affairs, and Student Accounting is the starting point for all IIT students (prospective, new, and continuing) seeking administrative and academic assistance.

Registrar

www.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 At the One Stop, you can get assistance, ask questions, and be pointed in the right direction for registration, change of major, student petitions, enrollment verification, transcripts, and more. You can get personal assistance with financial account information, paying tuition and fees, housing bills, and parking tickets, as well as obtaining information about financial aid.

to enforce academic policy, registration, grading, enrollment certification, course information, the production of diplomas and official transcripts, and other related university functions.

Research Institutes

IIT Research Institute (IITRI)

IITRI is IIT's not-for-profit contract research affiliate. With a focus on biomedical research, IITRI's staff of approximately 115 scientists and technicians conducts programs for both government and commercial sponsors. Specific areas of expertise include preclinical toxicology; carcinogenesis and cancer prevention; inhalation technology; molecular biology; analytical chemistry; and biodefense. David McCormick, IITRI Senior Vice-President and Director, can be reached at 312.567.4972. Web: www.iitri.org.

The Institute for Food Safety and Health (IFSH)

IFSH is a world class research institute that produces knowledge-based outcomes in the areas of food safety, food defense, and nutrition for stakeholders in government, industry, and academia. IFSH builds on and expands the vital work of the National Center for Food Safety and Technology (NCFST), a unique research consortium of IIT, the U.S. Food and Drug Administration (FDA), and the food industry. For more than 20 years, the center has provided a collaborative environment where scientists from industry, academia, and government pool their scientific expertise and institutional perspectives to ensure the production of safe, wholesome foods. IFSH has four operating centers that support the institute: the National Center for Food Safety and Technology (NCFST), Center for Nutrition Research (CNR), Center for Processing Innovation (CPI), and Center for Specialty Programs (CSP).

Within the FDA staff, Richard McDonald is Director, Division of Food Processing Science and Technology. Within the IIT Staff, Robert Brackett, IIT Vice President and IFSH Director, can be reached at 708.563.1577 or rbrackett@iit.edu. Jason Wan, IFSH Associate Director, can be reached at 708.563.8282 or jwan1@iit.edu. Web: www.iit.edu/ifsh.

Pritzker Institute of Biomedical Science and Engineering

The Pritzker Institute is an umbrella organization that enhances the biomedical science and engineering research activities on the IIT campus. The Medical Imaging Research Center (MIRC), the Center for Integrative Neuroscience and Neuroengineering research (CINNR), and the Engineering Center for Diabetes Research and Education (ECDRE), the Center for the Study of Condensed Soft Matter μ COSM, and the Biophysics Collaborative Access Team (BioCAT) are some of the Centers and activities that operate under the Institute. Each of the Centers has a Director and is described in more detail elsewhere in this document. The Pritzker Institute develops and coordinates relationships and programs with traditional science and engineering departments within IIT, as well as outside institutions, especially, Argonne National Laboratory, Rush Presbyterian Medical Center and the University of Chicago. Vincent Turitto, Director, can be reached at 312.567.6927. Web: www.iit.edu/pritzker_institute/.

Wanger Institute for Sustainable Energy Research (WISER)

WISER's mission is to continue to improve the quality of life and positively impact society while preserving our natural resources and the environment for future generations. Fulfillment of this mission will reduce our dependence on fossil fuels and, at the same time, provide sufficient and affordable sources of clean energy and water.

WISER cultivates close collaboration among numerous programs at IIT with a focus on development of energy-related interdisciplinary educational and research initiatives and proposals. Current WISER activities involve more than 50 faculty members from throughout IIT, spanning engineering, design, architecture, business, psychology, the sciences, and law. WISER plans to further enhance research and educational partnerships with the City of Chicago, State of Illinois, industry, national laboratories, and other universities. The goal of the institute is to play a leading role in identifying future research directions for shaping national and international energy policy and sustainability initiatives. Hamid Arastoopour, Director can be reached at 312.567.3038 or at arastoopour@iit.edu or contact Peg Murphy at 312.567.6881, murphym@iit.edu. Web: www.iit.edu/wiser.

Research Centers

Center for Accelerator and Particle Physics (CAPP)

CAPP provides a locus for interdisciplinary activities at IIT aimed at the continued development of research in elementary particle physics, at developing new particleaccelerator technologies, and at education and outreach to educational institutions and to the wider business, philanthropic and general public sectors. It serves as a base to coordinate the activities of a group of IIT faculty, graduate students, and staff from various departments currently involved in a number of research programs, and will promote substantial increases in such involvement through a close working relationship with other universities in the region and with Fermilab and Argonne National Laboratory (ANL). Daniel Kaplan, Director, can be reached at 312.567.3389 or at kaplan@iit.edu. Web: www.capp.iit.edu.

Center for Complex Systems and Dynamics (CCSD)

CCSD provides an interdisciplinary collaborative environment for fundamental and applied research for understanding and mathematically describing complex systems; developing mathematical and computational techniques for simulating, analyzing, and modifying their behavior; and applying these methods to various complex systems of national interest. Current research areas include nonlinear and stochastic phenomena in complex systems, multiagent systems, complex networks and adaptive systems, natural and industrial ecologies, dynamics of multiphase systems, fluid turbulence, molecular level modeling of physical systems, brain electrophysiology and computational neuroscience, and transportation systems. Found Teymour, Director can be reached at 312.567.8947 or teymour@iit.edu. Web: www.ccsd.iit.edu.

Center for Diabetes Research and Policy (CDRP)

CDRP is a multi-disciplinary center that includes scholars from engineering, scientific, social scientific, and legal fields. Currently, IIT's Engineering Center for Diabetes Research and Education (ECDRE); Institute for Science, Law and Technology (ISLAT); and Health and Disability Law Clinic in the Law Offices of Chicago-Kent College of Law (the Health Law Clinic) focus on various aspects of diabetes research, prevention, diagnosis, and treatment. The Center unites these entities to undertake scientific research, make policy assessments and recommendations, and provide legal advice for individuals with diabetes-related conditions who are participating in research, seeking access to care, or have been discriminated against because they have or are likely to develop diabetes. It also undertakes research into understanding the disease's mechanisms, designing new treatments, and discovering methods of monitoring and treating the complications of the disease. The CDRP collaborates with community and professional groups to increase education, awareness, and prevention.

Center for Electrochemical Science and Engineering

The Center conducts basic and applied research primarily in fuel cells and batteries, while preparing students for a career in advanced energy technology. Jai Prakash, Director, can be reached at 312.567.3639. Web: www.chee.iit.edu/research/cese/cese.htm.

Center of Excellence in Polymer Science and Engineering

The Center is an interdisciplinary research and education center established in 1990 through a grant from the Amoco Foundation, is devoted to the advancement of polymer science and engineering. Research is conducted on synthesis, rheology, characterization and processing of polymers. Education programs include concentrations for B.S., MAS (non-thesis), M.S. and Ph.D. degrees. Dave Venerus, director, can be reached at 312.567.5177 or venerus@iit.edu. Web: www.chbe.iit.edu/research/cepse.

Center for Integrative Neuroscience and Neuroengineering Research (CINNR)

CINNR's mission is to foster research in systems and behavioral neuroscience at the University of Chicago and neural engineering at Illinois Institute of Technology. Work in the Center proceeds from basic science and clinical efforts and emphasizes interdisciplinary approaches to understanding the nervous system. Nicholas Hatsopoulos, Co-Director, can be reached at 773.702.5594 or nicho@uchicago.edu. David Mogul, Co-Director can be reached at 312.567.3873, or mogul@iit.edu. Web: www.cinnresearch.org.

Center for the Molecular Study of Soft Condensed Matter (μ CoSM)

The Center is a multi-disciplinary center dedicated to the research of soft matter, both biological and synthetic. The center has substantial expertise in cell membranes, collagen, ECM, peptide mimetics, entangled polymers, networks, and the cytoskeleton. Particular emphasis is paid to establishing molecular structure/property/function relationships. The center houses faculty from Biology, Engineering, and Physics, and is a member of the Pritzker Institute of Biomedical Science and Engineering. Research relies equally on experimental, computational, and theoretical components, including neutron diffraction, x-rav diffraction and scattering, atomic force microscopy, Forced Rayliegh Scattering, micro- and bulk rheology, molecular dynamics simulations, and stochastic and statistical mechanical modeling. Jay Schieber, Director, can be reached at 312.567.3046, or schieber@iit.edu. Web: www.iit.edu/ucosm/.

The Center for Nutrition Research (CNR)

The Center supports the work of the Clinical Nutrition Research Center (CNRC), which conducts human nutrition and clinical research to determine the health benefits of foods and food components in a variety of study areas, including nutrient properties and bioavailability, obesity and satiety, diabetes and cardiovascular disease risk reduction, and infant and child nutrition. The unit also manages projects related to IFSH's Health Promoting Foods research arm. Britt Burton-Freeman, Director can be reached at 708.563.8276 or bburton@iit.edu. Web: www.iit.edu/ifsh/research_centers/ncnr/.

The Center for Processing Innovation (CPI)

The Center provides expanded process control and process validation capabilities for applied research through IFSH's GMP processing area, kitchen and pilot plant, BSL-2 processing innovation laboratory, fresh produce processing line, and the newly commissioned BSL-3 laboratory and biocontainment pilot plant. The unit also administers education and training services, and other targeted commercial projects. Alvin Lee, Director can be reached at 708.563.8277 or alec@iit.edu. Web: www.iit.edu/ifsh/research_centers/ncpi/.

The Center for Specialty Programs (CSP)

The Center administers key specialized programs, including customized laboratory proficiency testing services for all stakeholders. This center manages development and oversight of government project contracts with US FDA, USDA, Department of Homeland Security, and other regulatory agencies associated with food protection and nutrition. Jason Wan, Acting Director, can be reached at 708.563.8287 or jwan1@iit.edu. Web: www.iit.edu/ifsh/research_centers/css/.

Center for Strategic Competitiveness (CSC)

CSC is the nerve center for research and outreach activities of IIT Stuart School of Business, developing global partnerships to enhance innovation and creativity, and providing quality, high-level executive education customized to meet discipline-specific demands. Our mission is to develop Strategic Competitiveness into an approach to business that will enhance the ability of individuals, organizations, and governmental units to respond proactively and innovatively to global market challenges in today's and tomorrow's economy.

The CSC provides a cross-discipline approach to competitiveness and economic development, combining psychology (incisive decision making and leadership), design (creativity, innovation, and entrepreneurship), and engineering (sustainability). Our research and program efforts are developed within a network of partnerships, bringing together the knowledge and experience of executives, lawmakers, academics, and experts in an array of fields. The CSC is tasked with the responsibility of making certain that IIT Stuart School of Business is always evolving and adapting to the present and future demands of global business. We do this, in part, through a major portfolio of research, public information, and public awareness of competitiveness issues developed in partnership with a variety of funders. The CSC offices can be reached at 312.906.6524 or csc@stuart.iit.edu.

Center for the Study of Ethics in the Professions (CSEP)

CSEP was established in 1976 to promote research and teaching on practical ethical issues in the professions. Within IIT, CSEP pursues this mission by integrating ethics into IIT programs and courses and collaborating with faculty in teaching and research. The first ethics center to focus on the professions, CSEP continues to be one of the nation's leading ethics centers and is internationally recognized for its work on ethics in science, engineering, and related areas of business. CSEP is committed to multi-disciplinary and multiinstitutional research, to projects that combine empirical investigation with conceptual analysis, and projects that introduce and propagate innovations in teaching. Past projects have focused on such topics as intellectual property, decision-making involving engineers and managers, and ethics and societal implications of nanotechnology. There is a continuing emphasis on projects that integrate ethics education into technical courses, for example the development of methods of micro-insertion and Ethics Across the Curriculum. CSEP's initiatives to integrate ethics in the IPROs offer models for raising ethics awareness and providing experience of ethics problem solving for students in all IIT's disciplines and professional programs. Vivian Weil, Director, can be reached at 312.567.3472 or weil@iit.edu. Web: http://ethics.iit.edu/.

Center for Synchrotron Radiation Research and Instrumentation

The Center promotes application of the tools and techniques of synchrotron radiation to science and engineering research, with a particular focus on developing and operating experimental beam line facilities to serve the needs of various collaborative access teams at the Advanced Photon Source at Argonne National Laboratory. Carlo Segre, director, can be reached at 312.567.3498. Web: www.iit.edu/csrri/.

Center for Work Zone Safety and Mobility (CWZSM)

CWZSM works towards providing long-term solutions to highway work zone safety and mobility problems, by building a consortium of major work zone stakeholders including transportation agencies, road contractors, the trucking industry, and the insurance industry. By working together through the consortium, the stakeholders can combine their resources and knowledge. and work towards preventing the 50,000 work zone injuries and 1,000 fatalities that occur every year. The initiatives of the center focus on (1) developing highway work zone safety audit guidelines by addressing the concerns and interests of all stakeholders; (2) discovering/ developing/transferring new technologies and measures for improving work zone safety, and minimizing its negative impacts on private industries and the national economy; and (3) providing work zone safety training and education to the transportation community and the public. David Arditi, Director, can be reached at 312.567.3630 or arditi@iit.edu. Web: www.cwzsm.iit.edu.

Electric Power and Power Electronics Center (EPPEC)

IIT has long maintained high quality education and research programs in electric power and energy systems. The mission of the Electric Power and Power Electronics Center (EPPEC) is to make significant educational, research, and practical contributions to the fields of electric power, power electronics, electric machines, motor drives, and vehicular power systems. The tasks of the Center include the sponsorship of technical studies, which will enhance the role of university faculty, manufacturers, vendors, and consumers in power engineering research and education. The Center works with centers and departments across IIT, other institutions, government agencies, and industry to sponsor research projects, short courses, conferences, and seminars. Mahesh Krishnamurthy, Acting Director, can be reached at 312.567.7232 or ukrishn1@iit.edu. Web: http://power.iit.edu.

Energy +Power Center

The Center offers research and education programs that respond to the needs of the energy and power industries. The center's activities include the Energy/Environment/Economics (E^3) program.

Engineering Center for Diabetes Research and Education (ECDRE)

ECDRE's objective is to use engineering and sciencebased techniques to develop treatment modalities for diabetes and its many complications. ECDRE is the first center in the U.S. to focus on diabetes treatment. IIT faculty members, in collaboration with investigators and clinicians at the University of Chicago and Argonne National Laboratory, are working on a variety of diabetes-related research projects. ECDRE is a component of the Pritzker Institute of Biomedical Science and Engineering, which is developing a biomedical research thrust on the campus of IIT. Ali Cinar, Director, can be reached at 312.567.3637 or cinar@iit.edu. Web: www.iit.edu/ecdre/.

Fluid Dynamics Research Center

The Center consists of six faculty engaged in experimental, computational, and analytical studies of fluid flow and its control. The center has numerous research-quality experimental facilities including, high and low Mach number wind tunnels, jet facilities, water channels, anechoic room and an axial flow compressor. Extensive computational resources are available for numerical flow simulations. Areas of focus include active flow control for aerospace applications, aeroacoustics, contaminant dispersion predictions and vortex-surface interactions. David R. Williams, Director, can be reached at 312.567.3192. Web: http://fdrc.iit.edu.

High Performance Computing Center (HPCC)

HPCC is based on the successful collaboration among Illinois Institute of Technology faculty and the Office of Technology Services. The HPCC serves a critical computing need among IIT researchers: the availability of high performance computing resources. In particular, the HPCC charter has three main goals: to provide expertise on the integration of new computing equipment into IIT's HPC pool; to attract external funding for HPC infrastructure; and to promote HPC at IIT. The HPCC oversees the university's central research computing resources: the 32 processor gigawulf Linux cluster. Alex Flueck, Director, can be reached at 312.567.3625 or flueck@iit.edu.

International Center for Sensor Science and Engineering (ICSSE)

ICSSE coordinates education and research activities in sensor science and engineering. The center addresses significant national and international needs for research and development in sensor science. Current research activities include: biosensors, electrochemical sensors, nanosensors, physical sensors, computations for optimum sensor applications, pattern recognition and artificial intelligence in sensor systems, artificial chemical sensor arrays like electronic noses and tongues, prosthetic sensing like eyes, ears and noses, sensor modeling and design, the shared sensor technology user facility for extreme sensor evaluation, and sensors for chiral molecules. Sensor applications include medicine, environment, human health and safety, industrial and automotive, homeland security, and the NASA space station. Rong Wang, Director, can be reached at 312.567.3121 or wangr@iit.edu. Web: www.icsse.iit.edu.

The International Center for Sustainable New Cities (ICSNC)

The dual foci of ICSNC are education and research. Situated within the graduate program of the College of Architecture, the center will offer coursework at both a graduate and doctoral level. Planning at the urban scale demands an especially ambitious approach that embodies not only the artistry of physical design but also a score of other specializations, among them ecological design, engineering and new technologies, public policy, sociology, and economics. Whereas it is unrealistic to expect to train students in each and every one of these disciplines, it is not unreasonable to view the sustainable urban planner as a generalist, as someone conversant with the multitude of variables that have to be taken into account in the successful completion of such an extended task. The issue of research is likewise central to the center's mission, particularly at a doctoral level. Within the realm of theory, it is our primary intention to consider critically a broad range of innovative strategies, and to document the matrix of competing interests and concerns that must be brought to bear on the problem. The new program of landscape architecture within the college will assist in this matter. By means of alliances with other schools at home and abroad, we will offer a course of study and range of ideas that is significantly enriched through first-hand experience and travel. Harry Francis Mallgrave, Director, can be reached at 312.567-3269 or mallgrave@iit.edu. Web: www.icsnc.iit.edu/.

Medical Imaging Research Center (MIRC)

MIRC at the Pritzker Institute of Biomedical Science and Engineering promotes, coordinates, and fosters research and educational activities at IIT in medical imaging and related fields. Educational programs include B.S. and Ph.D. programs in Biomedical Engineering and a professional masters degree in Electrical and Computer Engineering. Current projects include: mapping the human brain, new x-ray imgaging techniques, computer-aided diagnosis, and imaging the heart. Miles Wernick, director, can be reached at 312.567.8818 or wernick@iit.edu. Web: www.iit.edu/mirc/.

National Center for Food Safety and Technology (NCFST)

NCFST, IFSH's cornerstone principal operating center, continues to operate under its long-time cooperative agreement between IIT and FDA, focusing on design and performance of a variety of collaborative and cooperative research projects across several focus areas, including microbiology, chemical constituents, allergens, food processing, packaging, methods validation, and nutrition. Robert Brackett, IIT Vice President and IFSH Director, can be reached at 708.563.1577 or rbrackett@iit.edu. Web: www.iit.edu/ifsh/research_centers/ncfst/.

Robert W. Galvin Center for Electricity Innovation

The Mission of the Robert W. Galvin Center for Electricity Innovation is to pursue groundbreaking work in the generation, transmission, distribution, management and consumption of electricity. The Galvin Center brings together faculty, students, researchers, industry, government, innovators, and entrepreneurs to collaborate to improve the reliability, security and efficiency of the electric grid and overcome obstacles to the national adoption and implementation of the smart grid. Andrew Barbeau, Managing Director, can be reached at 312.567.5013 or abarbeau@iit.edu. Web: www.iit.edu/galvin_center/.

Thermal Processing Technology Center (TPTC)

Through TPTC, faculty and students undertake research to support the needs of the materials processing and manufacturing industries. The center performs high quality basic and applied research in thermal processing technology of interest to the primary metals and manufacturing industry. In addition, the center provides training and education to enhance the human resources available to industry. Multi-disciplinary research teams are used to provide innovative crosscutting technological solutions to industrial materials processing problems. Philip Nash, Director, can be reached at 312.567.3056. Web: http://tptc.iit.edu.

Wireless Network and Communications Research Center (WiNCom)

Founded in 2006, WiNCom is an initiative of the Computer Science and Electrical and Computer Engineering Departments. Motivated by the continuing explosion in the use of the radio frequency spectrum, and the desire to increase RF spectrum utilization and efficiency, WiN-Com fuses the creative talents of faculty and students from across IIT. WiNCom's signature achievement is the 2007 establishment and ongoing operation of the IIT Spectrum Observatory, which is creating a continuous record of RF spectrum utilization in Chicago. Research programs include RF spectrum measurements; RF measurement data storage and analysis techniques; cognitive radio; communication system modeling; RF coexistence; and RF interference modeling and mitigation. Application areas are licensed and unlicensed spectrum, public safety, smart grid, and spectrum sharing. The Center has generated numerous technology transfers and spinoffs, including a commercial RF spectrum observatory network. Center researchers have ongoing engagements with the FCC and other government entities including the U.S. Commerce Department Spectrum Management Advisory Committee. Cynthia Hood, Director, can be reached at 312.567.3918. Dennis Roberson, Co-Director, can be reached at 312.567.3032.

Residence and Greek Life

www.iit.edu/housing

More than half of IIT's full-time undergraduates live on campus. Residence and Greek Life offers a wide range of accommodations, programs, and services designed to enhance campus life. Residence and Greek Life maintains residence halls and apartments designed to meet the different needs of IIT students, faculty, and staff. Within

Service, Education, and Outreach Centers

Center for Research and Service

The Center offers professional consulting services through the College of Psychology at IIT. The center supports its clients through research-based solutions that improve individual, team, and organizational performance. George M. Langlois, Director, can be reached at 312.567.6471. Web: www.iit.edu/~psyccrs/.

Center for Sustainable Enterprise

The Center can bring the many disciplines resident at the Illinois Institute of Technology together in a collaborative relationship with business corporations, other academic institutions, government agencies and members of the NGO community to identify, develop, communicate, and help implement practical and equitable business strategies that advance the ecological sustainability of the Greater Chicago Area, while fostering our current and future economic viability. M. Krishna Erramilli, Director, can be reached at 312.906.6543 or krish@stuart.iit.edu. Web: www.stuart.iit.edu/cse/home.html.

Energy/Environment/Economics (E^3)

 E^3 is an academic program of research and coursework for students in engineering. The research program encompasses areas of specialization that relate to energy, sustainable development, industrial ecology and environmental design. Hamid Arastoopour, WISER Director, can be reached at 312.567.3038.

Grainger Power Engineering Laboratory (GPEL)

GPEL focuses on studies related to electric power generation transmission, distribution, operation and controls. GPEL houses several graduate and undergraduate laboratories. Annual research support of more than \$400,000 is provided by federal and private agencies. S. Mohammad Shahidehpour, Director, can be reached at 312.567.5737. these buildings, the staff members coordinate academic and social programming, assist students with personal and academic concerns, supervise resident advisors and community desk assistants, and advise the Residence Hall Association. Please contact Residence and Greek Life for further information about these options.

Institute for Science, Law & Technology

The Institute for Science, Law & 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, multi-disciplinary 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, diabetes policy, environmental science, social networks, and intellectual property. In addition, institute staff and faculty draft laws and regulations and develop other programs that guide public policy decisions. Lori Andrews, Director, can be reached at 312.906.5359.

Invention Center

The Center helps students and faculty develop a studio approach to engineering. The center's philosophy is project-oriented, creativity-driven and encompasses all the stages of invention, including idea generation and development. prototype development and proof-of-concept, the patent process and commercialization. Francisco Ruiz, Director, can be reached at 312.567.3212. Web: www.iit.edu/~invention/.

Manufacturing Productivity Center (MPC)

MPC is the hub of all activities relating to manufacturing and industrial activities. Mazin Safar, Director, can be reached at 312.567.3624. Web: www.intm.iit.edu/cpd/intm/mpc.

Office of Intellectual Property and Technology Transfer

The Office of Intellectual Property and Technology Transfer supports all IIT efforts to build and sustain relationships with corporations and other external organizations. The office coordinates the process of identifying, evaluating, protecting, marketing, and licensing all IIT inventions and copyrightable material. Robert Anderson, Director, can be reached at 312.567.3462. Web: www.iit.edu/research/services/ttip/.

Spiritual Life and Service Learning

www.iit.edu/spiritual_life

The Office of Spiritual Life and Service Learning serves students of all faith traditions, as well as secular humanists and atheists. Together with student religious organizations and other university offices, the office sponsors activities for faith development, worship, socializing, and service. The office sponsors interfaith learning opportunties on campus, and provides information about religious resources both on and off campus. The director is also available to discuss personal or spiritual issues. Home to IIT's Service Learning programs, the office sponsors and supports regular community service activities, advises the Service Learning theme community, and connects interested students with volunteer opportunities both on and off campus.

The Office of Spiritual Life is located in MTCC 213. The director can be contacted at 312.567.3160, spiritual.life@iit.edu or service@iit.edu.

Student Activities

Co-curricular activities and events provide opportunities for students to expand their intellectual, social and recreational interests. The McCormick Tribune Campus Center (MTCC) is the site for feature films, comedians and live music. The campus center has lounges, study areas, meeting rooms, student organization offices, an auditorium, a ballroom, a cafeteria, a pub, and a recreation room. The Office of Student Activities oversees many student groups and acts as liaison between the administration and the various organizations. The campus is home to numerous student organizations including the Student Government Association (SGA), Graduate Student Association; the Residence Halls Association (RHA), which governs the hall councils; Greek Council, the governing organization for social fraternities and sororities; the National Society of Black Engineers (NSBE); Latinos Involved in Further Education (LIFE); Union Board, which plans much of the campus social and cultural activities; Technology News, the student newspaper; WIIT-FM, the student radio station; and Commuter Student's Association, the commuter student organization.

Student Affairs

www.iit.edu/student_affairs

The Office of the Dean of Students oversees many areas of student life and serves as the primary advocate and ombudsperson for students. The office also manages the student conduct process. Students, faculty, and staff are encouraged to contact the office for help or referrals.

Activities outside the classroom and laboratory complement and enhance IIT's central educational mission. IIT

Student Center for Diversity and Inclusion www.iit.edu/scdi

Illinois Institute of Technology is dedicated and committed to building and sustaining a diverse and inclusive campus community that values and respects all members. The purpose of the Student Center for Diversity and Inclusion is to provide programs, research, advocacy, and advice on issues, policies, and practices that affect the University's commitment to diversity and inencourages 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 IIT Student Handbook.

clusion. In support of that commitment, the work of the Center is organized around a concept of diversity that is practical and includes multiple social and cultural identities, such as race, gender, sexual orientation, class, group affiliation, ability, national origin, and religion. For additional information on the Center, please visit **www.iit.edu/scdi**.

Student Health and Wellness Center

www.iit.edu/shwc

The Student Health and Wellness Center (SHWC) at Illinois Institute of Technology provides quality and costsensitive healthcare tailored to the unique and diverse 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 provide primary care, specialty care, urgent care, diagnostic services, psychotherapy and mental health support, health promotion, and wellness programs.

SHWC provides diagnosis and treatment of common illnesses and injuries with the ability to dispense medication and/or provide appropriate prescriptions. We also provide immunizations, allergy injections, and walk-ins for urgent care. In addition, SHWC provides gynecological care and sexual health screening for men and women. A small fee may incur for labs, diagnostic tests, immunizations, and medication given on site.

The SHWC provides administrative oversight of the IIT Student Health Insurance Plan. Aetna Health insurance

Technology Commercialization

The Office of Intellectual Property and Technology Transfer, supports all IIT efforts to build and sustain relationships with corporations and other external organizations. The office coordinates the process of identifying, evaluating, protecting, marketing and licensing is offered to currently enrolled students at IIT. Health insurance is not a requirement to use the SHWC.

Our counseling services include psychotherapy, referral, and medication management. Treatment length varies, depending on individual needs, and can last up to 16 individual counseling sessions per student while group therapy imposes no session limits. Our 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 clinical services are provided by a team of culturally sensitive professionals. We provide comprehensive clinical services and outreach programs to IIT students. In addition, SHWC is a resource for consultation to faculty, staff, and parents of IIT students. We are located in the IIT Tower, 3rd Floor. To schedule an appointment call 312.567.7550.

all IIT inventions and copyrightable material. Assistance with business startup issues is available. Robert Anderson, Director, can be reached at 312.567.3462 or anderson@iit.edu. Dr. Myron Gottlieb, Manager, can be reached at 312.567.3596 or gottlieb@iit.edu.

Technology Services

www.iit.edu/ots

The Office of Technology (OTS) supports IIT's primary technology services including administrative systems, myIIT, and network and telephone infrastructure. OTS maintains over 500 computers in its classrooms, labs, and public terminals throughout the Main, Adams Street, and Rice Campuses. The computers in the classrooms and labs are refreshed on a three-year cycle, to ensure that students have access to equipment that supports their academic activities. The classroom and lab instructional software is reviewed and updated every semester by the IIT Software Committee. OTS also supports remote printing from personal laptops/desktops to printing release stations located in various computer labs and public areas. Additional information about this service is available on the IIT Print channel and the OTS portal website, accessible through the myIIT Training and Support tab.

OTS manages the myIIT web portal my.iit.edu, which provides personalized access to email, online course registration, Blackboard, OTS Support, student life, and other content. All IIT students receive an email address in the format: username@hawk.iit.edu. IIT email is integrated into each student's Google Apps for Education account, which is accessed via the myIIT portal. Google Apps for Education also includes collaboration tools such as Google Docs, Sites, Groups, and more. Supplemental class materials are available through Blackboard, IIT's

Undergraduate Academic Affairs

www.iit.edu/ugaa

The Office of Undergraduate Academic Affairs (UGAA) provides a variety of academic support services for all undergraduate students from the time of admission to graduation. These services include academic advising; evaluation of transfer credits from both United States and international schools; academic program audits; student petitions; course repeats for a change of grade; change of major; monitoring of academic progress; certification

Writing Center

www.iit.edu/csl/hum/resources/writing_center.shtml

IIT students can seek assistance with written and oral assignments at the IIT Writing Center, located in Siegel Hall 232/233/234. Tutors are available to assist students enrolled in writing-intensive courses (Introduction to the Profession, C-courses, and IPROs). Tutors specializing in English as a Second Language are also available to

course management system, where instructors post lectures, notes, IIT Online video lectures, and other course information.

The OTS Support Desk is the central point of contact for technology support at IIT. Support Desk staff provide technical troubleshooting, account management, and configuration assistance to students, faculty, and staff. OTS Support is available through myIIT, including 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 Support tool in myIIT, sending a request via email (**supportdesk@iit.edu**), or by calling the Support Desk at 312.567.3375 (on-campus ext.7-DESK).

IIT provides Internet access through its wired and wireless networks. Most Main Campus buildings have wired Internet access and wireless is available in all residence halls and academic buildings, as well as in most other Main Campus buildings. Visit the OTS website to view IIT's current WiFi coverage and to learn how to connect to the IIT network.

Visit the OTS website: **www.iit.edu/ots** and the portal website on the *Training and Support* tab in myIIT for the most up-to-date information and useful details about IIT's technology.

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. DegreeWorks, the online degree audit system is monitored and maintained by the Office of Undergraduate Academic Affairs.

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.

Graduate Degree Programs and General Requirements

The university's Armour College of Engineering, College of Architecture, Chicago-Kent College of Law, Institute of Design, Institute of Psychology, School of Applied Technology, and Stuart School of Business award

Doctoral Degrees

Applied Mathematics Architecture Biology Biomedical Engineering Chemical Engineering Chemistry Civil Engineering Collegiate Mathematics Education Computer Engineering Computer Science Design

Law Degrees

Doctor of Science Laws (J.S.D) Juris Doctor (J.D.) Master of Laws (LL.M.) Master of Intellectual Property Management and Marketing J.D./LL.M. in Family Law J.D./M.B.A. (joint degree)

Master of Science Degrees

Applied Mathematics Biology Chemical Engineering Chemistry Civil Engineering Computer Engineering Computer Engineering and Electrical Engineering (dual degree) Computer Science and Master of Chemical Engineering (dual degree) Computer Science Electrical Engineering Environmental Engineering Environmental Management Finance Food Process Engineering Food Safety and Technology Information Architecture

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.

Electrical Engineering Environmental Engineering Management Science Materials Science and Engineering Mathematics Education Mechanical and Aerospace Engineering Molecular Biochemistry and Biophysics Physics Physics Psychology Science Education Technical Communication

J.D./M.S. in Environmental Management (joint degree) J.D./LL.M. in Taxation (joint degree) J.D./M.S. in Financial Markets (joint degree) J.D./LL.M. in Financial Services Law (joint degree) J.D./M.P.A. (joint degree) J.D./Master of Public Health (joint degree in cooperation with University of Illinois at Chicago)

Manufacturing Engineering Marketing Analytics and Communication Materials Science and Engineering Mathematics Education Mechanical and Aerospace Engineering Molecular Biochemistry and Biophysics Personnel and Human Resources Development Personnel and Human Resources Development (dual-degree w/ B.S. in Psychology) Physics Psychology Rehabilitation Counseling* Rehabilitation Counseling (dual-degree w/ B.S. in Psychology)* Science Education Technical Communication and Information Design

* application to these programs does not require the GRE

Professional Master's Degrees

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

Architecture (full-time only) Architecture/Integrated Building Delivery (dual degree) Architectural Engineering **Biological Engineering** Biology Biomedical Imaging and Signals Business Administration (M.B.A.) Business Administration/Master of Design (dual degree) Business Administration/ M.S. in Environmental Management and Sustainability (dual degree) Business Administration/ M.S. in Marketing Communication (dual degree) Business Administration/ Master of Public Administration (dual degree) Chemical Engineering Chemical Engineering and M.S. in Computer Science (dual degree) Chemistry Chemistry in Analytical Chemistry Chemistry in Materials Chemistry Computer Science

Construction Engineering and Management Cyber Forensics and Security Design (full time only) Design Methods Electrical and Computer Engineering Electricity Markets Environmental Engineering Food Process Engineering Food Safety and Technology Geoenvironmental Engineering Geotechnical Engineering Health Physics Industrial Technology and Operations Information Architecture Information Technology and Management Integrated Building Delivery Landscape Architecture Manufacturing Engineering Materials Science and Engineering Mathematical Finance Mathematics Education Mechanical and Aerospace Engineering Network Engineering Power Engineering Public Administration (M.P.A.) Public Works Science Education Structural Engineering Telecommunications and Software Engineering Transportation Engineering VLSI and Microelectronics

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 better scheduling flexibility than completion of the two degrees separately. Students maintain the undergraduate status, while completing graduate coursework, and can maintain financial aid eligibility when applicable. Co-terminal degree programs allow currently enrolled IIT undergraduate students to complete both a Bachelor's and Master's degree, in as few as five years.

Biological and Chemical Sciences

- Bachelor of Science in Biochemistry/Master of Biology with Biochemistry Specialization
- Bachelor of Science in Biochemistry/Master of Science 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 Biochemistry/Master of Food Safety and Technology
- Bachelor of Science in Biology/Master of Food Safety and Technology

Civil and Architectural Engineering

Bachelor of Science in Architectural Engineering/Master of Architectural Engineering

- Bachelor of Science in Architectural Engineering/Master of Construction Engineering and Management
- Bachelor of Science in Architectural Engineering/Master of Structural Engineering

Bachelor of Science in Civil Engineering/Master of Construction Engineering and Management

- Bachelor of Science in Civil Engineering/Master of Environmental Engineering
- Bachelor of Science in Civil Engineering/Master of Geotechnical Engineering
- Bachelor of Science in Civil Engineering/Master of Structural Engineering
- Bachelor of Science in Civil Engineering/Master of 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 Physics/Master of Computer Science
- Bachelor of Science in Physics/Master of Science in Computer Science

Electrical and Computer Engineering

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

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

Physical Science

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 IIT 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, IIT's graduate certificate programs are eligible for the Gainful Employment Programs (see page 53). For a complete list of eligible certificates, see www.iit.edu/grad_adm/.

Biological and Chemical Sciences

Analytical Method Development Analytical Spectroscopy Characterization of Inorganic and Organic Materials Chromatography Food Safety and Technology Synthesis and Characterization of Inorganic Materials Synthesis and Characterization of Organic Materials

Chemical and Biological Engineering

Biological Engineering Current Energy Issues Food Process Engineering Food Processing Specialist Particle Processing Pharmaceutical Engineering Polymer Science and Engineering Process Operations Management

Civil, Architectural, and Environmental Engineering

Air Resources Construction Management Earthquake and Wind Engineering Design Geoenvironmental Engineering Hazardous Waste Management Indoor Air Quality Infrastructure Engineering and Management Transportation Systems Planning Water and Wastewater Treatment

Computer Science

Computational Intelligence Computer Networking and Telecommunications Cyber-Physical Systems Data Analytics Distributed and Cloud Computing Information Security and Assurance Information Systems Software Engineering

Electrical and Computer Engineering

Advanced Electronics Applied Electromagnetics Communication Systems Computer Engineering Control Systems Electricity Markets Power Electronics Power Engineering Signal Processing Wireless Communications Engineering

Environmental Management

Compliance Pollution Prevention Sustainable Enterprise

Information Technology and Management

Advanced Software Development Cyber Security Management Cyber Security Technologies Data Center Operations and Management Data Management and Analytics Digital Voice and Data Communications Technologies Information Technology Innovation Leadership and Entrepreneurship System Administration Systems Analysis Web Design and Application Development

Lewis Department of Humanities

Instructional Design Technical Communication

Mechanical, Materials and Aerospace Engineering Computer Integrated Design and Manufacturing

Product Quality and Reliability Assurance

National Center for Food Safety and Technology

Food Process Engineering Food Processing Specialist Food Safety and Technology

Physical Sciencs

Radiological Physics

Institute of Psychology

Compensation Management Psychiatric Rehabilitation Rehabilitation Engineering Technology

Professional Certificates

Stuart School of Business

Business Administration Business Analyst Corporate Finance Entrepreneurial Finance Financial Economics Financial Modeling Financial Toolbox Fundamentals of Finance Innovation and Emerging Enterprises

Undergraduate Programs

A complete description of undergraduate programs and admission requirements is available from the Office of Undergraduate Admission at http://www.iit.edu/undergrad_admission/. Investments Marketing Management Risk Management Trading

Public Administration Nonprofit and Mission-Driven Management Public Management Security, Safety, and Risk Management

Synopsis of Graduate Studies at IIT

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 Graduate College Office of 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 www.iit.edu/graduate_college/academic_affairs/FormsGradStu.shtml.

1.	For applicants Formal application	Form or Application Required Regular application and all supporting materials in- cluding official transcripts, letters of recommenda- tion, test scores (if required), professional statement, portfolio (if required) and application fee.
2.	Admission decision	Admission letter from the Office of Graduate Admis- sion 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 my.iit.edu, under the Academics tab. Continuing students who are not enrolling for the current term must file a re- quest for leave or university withdrawal (see the sec- tion on Leave of Absence).
4.	Approval of the program of study	Form G401 must be submitted by the student online at www.iit.edu/graduatecollege/ academicaffairs/FormsGradStu.html and may be electronically rayised with advicer approval
5	Preliminary M.S. thesis approval	Form G501A (if required)
6.	Final thesis/ comprehensive examination for M.S. or MAS where applicable	Department submits Form G303. (if required).
7.	Final M.S. Thesis Committee appointed	Form G301B (if required).
8.	Thesis fee (if applicable)	Bursar's receipt.
9.	M.S. thesis approval signed by the thesis examiner	Form G501B.
10.	Completion of courses and other requirements	Listed on Form G401 and Form G406.
11.	Listed on Form G401 and Form G406.	Listed on Form G401 and Form G406.
12.	Fulfillment of all financial obligations to the university	
12.	Commencement (attendance is voluntary)	Registrar announces details in spring semester (one ceremony per year).
13.	Diploma	Registrar will mail diplomas four to six weeks after semester grades are reported, except spring semester when diplomas are distributed at the commencement ceremony to participants who have met all degree re-

quirements.

	For admitted and continuing Ph.D. students	
3.	Registration	Registration may be completed online at my.iit.edu un- der the Academics tab. Continuing students not en- rolling for the current term must submit a request for leave or university withdrawal form (see the section on Leave of Absence).
4.	Approval of the program of study	Form G401 must be submitted by the student online at www.iit.edu/graduate_college/ academic_affairs/FormsGradStu.html and will be electronically approved by the faculty advisor and aca- demic unit head/department chair. The form may be revised electronically with advisor approval.
5.	Ph.D. qualifying examination	Department administering exam submits Form $G303^*$.
6.	Ph.D. comprehensive examination	Form G301A. Department submits exam results on Form G309.*
7.	Fulfillment of Ph.D. residency requirement	No form needed.
8.	Appointment of the thesis examining commit- tee/comprehensive examination committee	Form G301A.
9.	Preliminary Ph.D. thesis approval	Form G501A
10.	Final Ph.D. thesis committee appointed	Form G301B.
11.	Final thesis defense /oral examination	Department submits exam results on Form G309.*
12.	Thesis fee	Bursar's receipt.
13.	Ph.D. thesis approval signed by the thesis examiner	Form G501B
14.	Completion of courses and other requirements	Listed on the Program of Study or Revised Program of Study that are filed and approved electronically.
15.	Application for Graduation	Application for Graduation Form G527 is filed electron- ically in Banner Self-Service. (Check deadline listed in the Academic Calendar for the semester of desired grad- uation.)
16.	Fulfillment of all financial obligations to the university	
17.	Commencement (attendance is voluntary)	Registrar announces details in spring semester (one cer- emony per year).
18.	Diploma	Registrar will mail diplomas four to six weeks after semester grades are reported, except spring semester when diplomas are distributed at the commencement ceremeony to participants who have met all degree re- quirements.

Note: Copies of the forms, applications, and the sequence of events may be obtained from the Graduate College Office of Academic Affairs website, www.iit.edu/graduate_college/academic_affairs/. *Forms G303 and G309, Exam Results Forms, are not given to students.

Academic units send G303 and G309 forms to the Office of Academic Affairs.

Synopsis of Co-Terminal Degree Studies at IIT

Co-terminal degrees provide an opportunity for students to gain greater knowledge in specialized areas while completing a smaller number of credit hours with better scheduling flexibility than completion of the two degrees separately. Students maintain the undergraduate status, while completing graduate coursework, and can maintain financial aid eligibility when applicable. Co-terminal degree programs allow currently enrolled undegraduate students to complete both a Bachelor's and a Master's degree, in as few as 5 years.

Admission

A minimum undergraduate cumulative grade point average (GPA) of 3.25/4.0 is required for admission. Some coterminal degree programs may require a higher minimum cumulative undergraduate GPA. All other graduate application requirements in force at the time of application to the co-terminal degree program will apply. Currently enrolled undegraduate students may seek admission to a co-terminal degree program as early as the fourth (4th) semester of undegraduate study. Questions regarding coterminal graduate admission should be addressed to the Office of Graduate Admission, at **inquiry.grad@iit.edu**

Program of Study

Before completion of 9 credits of graduate coursework applicable to the co-terminal degree program, a Program of Study must be filed with and approved by the graduate academic advisor, the academic unit head, and the Office of Graduate Academic Affairs. The Program of Study is used to monitor the successful completion of the master's degree requirements.

Academic Standing

Students who are admitted to a co-terminal degree program follow all graduate academic rules in force at the time of admissions to the program and throughout its completion. Co-terminal degree students must maintain a 3.25/4.0 cumulative GPA in all undergraduate and graduate courses to remain in good standing. If the combined cumulative GPA falls below 3.25, at the completion of any semester, the student will be dismissed from the co-terminal program.

Dismissal

A student who is dismissed from a co-terminal degree program may reapply for admissions consideration, to the respective master's degree program at a later time, but will not be re-admitted to a co-terminal degree status. All graduate rules in force at the time of reapplication and admission to the standard master's degree program, including a minimum of 30 credits for a Professional Master's program and 32 credits for a Master of Science program, subject to the academic rules of that discipline, will be required. The dismissed co-terminal degree student's courses, used to fulfill any undergraduate degree requirements, may not be used to fulfill the standard master's degree program requirements.

Admission

Application for Admission

Application information and forms for degree and non-degree admission may be accessed by visiting **www.iit.edu/graduate_admission/**.

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

Students who do not register for the semester they originally applied for must contact the Graduate Admission

Degree-Seeking Versus Non-Degree Status

A degree-seeking student is a registered student who submitted an application for admission as a degreeseeking student, was accepted by an academic unit in a specific degree program, and received a formal letter of admission. Degree-seeking students are required to register every semester except summer unless they receive special permission in writing for a leave of absence (Form G216) from the Graduate College, Office of Academic Affairs.

A non-degree student is a registered student who holds an undergraduate degree from an accredited institution, Office and request to defer their admission for up to one year. Deferral requests may be submitted to gradstu@ iit.edu. Transcripts must be submitted for all courses attempted at other institutions. Students wishing to register more than one year after the initial application must apply as a new student and resubmit all documents and fees.

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

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

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

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

Admission as a Degree-Seeking Student

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

- 1. Official transcripts, or certified copies, of all academic work at the college level or above.
- 2. Professional Statement
- 3. Required Test Scores
- 4. Letters of recommendation
- 5. Application fee

All applicants are required to submit GRE general test scores. A minimum score of 292 (quantitative + verbal) and 2.5 (analytical writing) is required for M.S./MAS applicants. Ph.D. applicants must meet the minimum requirements of 298 (quantitative + verbal) and 3.0 (analytical writing). Individual departments, colleges and institutes of IIT 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.

Admission as a Certificate Student

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

Admission as a Non-Degree Student

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

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

A final degree-seeking admission decision may be deferred until the requisite GPA has been achieved in study as a non-degree student, or until the required documents are submitted. Non-degree students seeking to convert to degree-seeking status must complete a regular online application to a degree program prior to the completion of nine credit hours of study. If a non-degree student applies for and is granted admission to a degree program, a maximum of nine credit hours of approved coursework taken as non-degree student The IIT code number is 1318. The GRE requirement may be waived for applicants to professional master's degree programs who hold bachelor's degrees from an accredited degree program at a U.S. college or university with a cumulative GPA of 3.0/4.0 or higher. The required minimum cumulative undergraduate GPA for regular admission is 3.0/4.0. Students with a 2.5/4.0 GPA may be admitted as non-degree students with probationary status. (See Admission as a Non-Degree Student.)

Applicants to Chicago-Kent College of Law must submit LSAT scores and other documentation as required by the law school. Stuart School of Business applicants are required to submit GMAT or GRE, and other documentation as required by the business school. Prospective students can obtain more information about admission requirements for Chicago-Kent College of Law at http://www.kentlaw.edu/ and for Stuart School of Business at http://www.stuart.iit.edu/.

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

certificate. Certificate students are permitted to enroll in as many credit hours as are necessary to complete the certificate.

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

and passed with a grade of B or better may be applied to the degree.

- 2. Applicants that must complete specific prerequisite courses prior to consideration of admission to a degree-seeking program. Courses taken in this classification are not counted toward degree requirements.
- 3. Applicants that do not intend to acquire a graduate degree in any specific discipline and wish to enroll in a variety of courses. Students may not pursue or earn a graduate certificate or degree while admitted in this status. Course credits earned are for continuing professional education.

The Office of Graduate Admission will notify non-degree students of the conditions under which they are admitted. Students should also refer to the section on transfer credit.

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

International Applicant Requirements

General Requirements

International applications are incomplete until the following are received:

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

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

Ph.D. applicants must meet the minimum requirements of 298 (quantitative + verbal) and 3.0 (analytical writing). Individual departments, colleges and institutes of IIT 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.

English Competency

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

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

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

By accepting admission to the university, you are also agreeing to take any additional English courses the Graduate College deems necessary in accordance with the English Assessment test. Students whose TOEFL, IELTS, or PTE and assessment test scores indicate they must take two or three English courses will have the opportunity to take an IIT English exam near the end of their first course to determine whether their English has improved enough to exempt them from the additional course(s). This exam will be given only to students enrolled in the English courses.

All students have the option to retake the TOEFL, IELTS, or PTE exam at any time before arrival and registration in their first semester at IIT. If the scores on the new exam are higher than on the previous exam, they will be used to determine the need to take the English Assessment exam, and placement in English courses.

Students are responsible for making arrangements to retake the TOEFL, IELTS, or PTE and having the official scores from Educational Testing Service, IELTS International, or Pearson's VUE submitted to IIT. Applicants should have the official test results sent from the appropriate testing agency to the Office of Graduate Admission, Illinois Institute of Technology, 10 W. 33rd Street, Room 203, Chicago, Illinois 60616. The IIT school code number is 1318.

Financial Support

IIT funds available to assist international students are limited and are usually awarded to a small number of selected students with outstanding academic credentials. Applicants on F-1 student visas are not eligible for part-time employment during their first year at IIT. International students must provide a certified financial affidavit from a responsible government official, or an official of a recognized financial institution, certifying that the student has (or will have available) funds to cover their entire period of study at IIT, and that the funds are free from restrictions and immediately available to cover a period equivalent to one calendar year. The I-20 or DS-2019 cannot be issued until an acceptable affidavit of financial support is received. Additional funds will be needed for travel expenses. Simple statements from parents or relatives to pay all expenses are not acceptable. Bank statements are not acceptable unless accompanied by a certified statement that the funds may be transferred to the United States for the student's use. Documents must be dated within 6 months of the student's beginning date.

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

Readmission for a Second Graduate Degree

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

Newly Admitted Students

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

Arrangements for campus housing must be made directly with the Director of Housing, Illinois Institute of Technology, 3303 S. State St., Chicago, IL 60616 (phone:

Enrollment Confirmation and Deferral Requests

At the time of admission, the student should submit a non-binding Intent to Enroll Form at http:// gradenrol.iit.edu/joiniit/joiniit.htm, or send an email to joinus@iit.edu, to reserve a place in the program. All students who wish to defer their enrollment to the sub-

Immunization Requirement

In accordance with Illinois law, all students born on or after January 1, 1957, and enrolling at IIT for the first time after July 1, 1989, must supply health provider-documented evidence of vaccination for diphtheria, tetanus, measles, rubella and mumps. Transfer students are considered as first-time enrolled students. Students enrolling for the first time during a summer session may be permitted to enroll in the subsequent fall semester before providing proof of immunity. Students who wish to enroll only in one class per semester or via IITV at corporate sites may file a written request for an exemption. Exemption from one or more of the specific requirements may also be granted based on documented 312.567.5075) or email housing1@iit.edu. Admission does not include commitments for room and board. A cash deposit is required with the application for housing. In general, IIT cannot provide housing assistance for

Continuation for a second degree is contingent upon ad-

mission in the second program. Additional information

is available from the Office of Graduate Admission.

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 IIT in time for the initial registration advising date. If students cannot arrive before the last day of late registration, the Office of Graduate Admission must be notified at gradstu@iit.edu.

sequent semester must request the deferment by contacting the Graduate Admission Office (gradstu@iit.edu, 312.567.3020.). International students may be required to submit a new bank statement.

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 Center for a nominal fee. The Certification of Immunization form is available at http://www.iit.edu/~shc/forms/ImmunizationReq.pdf. Questions regarding this policy should be directed to the Student Health 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.

IIT Graduate Bulletin 2012-2014

Registration

Full-Time Versus Part-Time Status

Full-time students are regular, matriculated students that meet any of the following criteria:

- (a) Register for a minimum of nine credits per semester (six credits in summer).
- (b) 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 hours. Consult the International Center.
- (c) 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 advisor and the endorsement of the Graduate College's Office of Academic Affairs.)

Who Should Register

Any graduate student who is using university facilities and/or faculty time must register for a minimum of one credit 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

Course Numbering

Course numbers 100–399 are primarily used for undergraduate courses. Courses 400–499 may be used for minor credit or as prerequisites when taken as part of an approved graduate program (see department requirements:

Course Descriptions

Course descriptions are available in the Academic Programs section of this bulletin and online at my.iit.edu, under the Academics tab **Note:** Full-time international students must fall into categories (a) or (b). International students enrolling less than full-time in the semester of graduation or falling into category (c) must file a petition (less than full-time eligibility) in the International Center by registration deadline. In order for the nine 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 Graduate College's Office of 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.

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 semester credit. The petition must be endorsed by the student's advisor and academic unit head, and forwarded to the Graduate College's Office of Academic Affairs for approval.

a maximum of 12 credit hours of 400 level classes may be included). Courses numbered 500–799 are graduate level and are primarily for graduate students; the grade earned by graduate students must be a "C" or better.
Registration for Fall and Spring Semesters

Specific procedures and regulations for registration are found each semester at my.iit.edu, under the Academics tab. The schedule for the spring semester is available the second week of November, and schedules for the summer session and the fall semester are available the second week of April. Students who were admitted to, but did not attend, IIT 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 research courses numbered 591, 594, 597, and 691 must receive written or online approval from their faculty advisor before regis-

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

IPRO Registration

Graduate students may serve as project leaders on an Interprofessional Project (IPRO). A student who wishes to do so must first consult his or her academic advisor and the project advisor. With the approval of both, the student should register for IPRO 597.

Change of Registration After Initial Registration

The term "change of registration" means adding a course (a "course" includes courses, projects or research courses/ hours); dropping a course; shifting from one section to another in the same course; or changing the number of credits 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.

The Change of Registration may be completed in the myIIT portal in Banner Self Service. Students requiring assistance may contact the Office of the Registrar, registrar@iit.edu. A course may be dropped during the first two weeks of the regular semester for refund or credit, and during the first week of the summer semester. A course may be withdrawn with no refund or credit betration. These registrations may be completed through web registration if an online permit is submitted by the course advisor/instructor.

Newly admitted and continuing students in good academic standing may register in advance in November (for spring) or April (for summer or fall) of each year. Students may also register in August (for fall), January (for spring) or in May and June (for summer). Registration confirmations are sent via email within 24 hours of completing registration. For questions concerning registration procedures, students should contact the Office of the Registrar at 312.567.3100 or at registrar@iit.edu.

thesis defense or doctoral oral defense may petition to register for GCS 600 Continuation of Graduate Study for 1 credit, at a nominal charge. The permit for enrollment in this course is approved by Graduate Academic Affairs after confirmation of the defense result. Form G701 is used to requise the GCS600 permit.

tween 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 Graduate College, Office of Academic Affairs. No registration change or withdrawal is official until the form is approved by the Registrar's Office. 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 Student Services Center. 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 "Who Should Register".)

Withdrawal From the University

A student who wishes to withdraw should first consult his academic advisor. The advisor 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 foreign student advisor in the International Center as well. For withdrawal, a regular graduate student must complete the electronic withdrawal form online in the myIIT portal by selecting the option from the Academic Affairs Channel. Withdrawal from IIT is not complete until an official email is received by the student confirming its completion.

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 advisor stating that the student is qualified. An Undergraduate student registering for more than nine credit hours of graduate courses must also obtain written approval from the Graduate College, Office of Academic Affairs. This approval must be presented at the time of 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 Graduate College's Office of Academic Affairs. 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 IIT. No credits approved toward the undergraduate-degree requirements will transfer into any graduate program at IIT. Students should consult the rules for transfer of credit under "Transfer Credits".

Academic Policies for Continuation of Studies

Leave of Absence

Degree-seeking students who intend to leave IIT for one semester or more must complete the online leave of absence form in the myIIT portal by selecting the option from the Academic Affairs Channel. A leave of absence will not be granted for more than one year, at which time, a request for an extension of leave may be submitted. A leave of absence will not extend the time limit required for the completion of a degree. A leave will not be approved after the sixth week of the current semester. A student who has not renewed his leave of absence and has not registered for courses as of the end of his respective leave must petition for reinstatement to the Graduate College, Office of Academic Affairs. Degree-seeking students who do not plan to return to the program should submit the Withdrawal Form. Nondegree 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".

Note: International students must also receive 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 and Enrollment After an Absence

Degree-seeking graduate students who discontinue their studies without an official request for leave of absence may later be refused reinstatement or enrollment at IIT. Students with an unofficial interruption of studies must petition for reinstatement to the Graduate College's Of-

Grade Point Average

Satisfactory performance in the graduate divisions is defined as the maintenance of a minimum cumulative GPA of 3.0/4.0, as reported by the registrar. The minimum GPA for graduation is 3.0/4.0. This figure is based only on those courses that appear on the approved program of study and not on the total cumulative GPA reported by

Academic Probation

A student whose cumulative GPA falls below 3.0/4.0 is no longer in good standing and must petition the Graduate College, Office of Academic Affairs for permission for provisional enrollment by submitting form G702. 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

Co-Terminal Degree

Academic Standing

Students who are admitted to a co-terminal degree program follow all graduate academic rules in-force at the time of admissions to the program and throughout its completion. Co-terminal degree students must maintain a 3.25/4.0 cumulative GPA in all undergraduate and graduate courses to remain in good standing. If the combined cumulative GPA falls below 3.25, at the completion of any semester, the student will be dismissed from the co-terminal program. fice of Academic Affairs. Students should contact the Graduate College, Office of Academic Affairs for additional information. Procedures for filing a petition may be found within the "General Policies" section of this bulletin.

the registrar; there is no exception or waiver to this rule. If a student repeats a course, the last grade issued for the course will be used to compute the cumulative GPA and the program of study GPA. Students should consult the section on repeating a course within this bulletin.

the cumulative GPA. Dismissal will occur when a student fails to make the requisite academic progress during the probationary period. Students may not register for Coop while on academic probation. If a student's GPA in his or her approved program of study is below 3.0, then graduate courses approved on a revised Program of Study Form G406 may be added to the program until the corresponding GPA is at least 3.0, with the approval of the Graduate College, Office of Academic Affairs.

Dismissal

A student who is dismissed from a co-terminal degree program may reapply for admissions consideration, to the respective master's degree program at a later time, but will not be re-admitted to a co-terminal degree status. All graduate rules in-force at the time of reapplication and admission to the standard master's degree program, including a minimum of 30 credits for a Professional Master's program and 32 credits for a Master of Science program, subject to the academic rules of that discipline, will be requred. The dismissed co-terminal degree student's courses, used to fulfill any undergraduate degree requirements, may not be used to fulfill the standard master's degree program requirements.

Credit Requirements

Unless otherwise specified, all master's degree candidates must complete a minimum of 30 credits beyond the bachelor's degree at IIT. Consult this bulletin on the total credit hour requirements for each degree. A maximum of nine semester hours, earned with "A" or "B" grades, may be transferred from other accredited institutions.

Ph.D. candidates must complete a minimum of 84 credits beyond the bachelor's degree.

Each Ph.D. student must include the equivalent of at least one year of full-time work devoted to research. In general, this requirement is fulfilled by registering for a minimum of 24 credit hours of research. However, some departments require a more extensive research experience. The upper limit is 48 credit hours for research. The remaining credit hours required for the Ph.D. degree, a minimum of 36, are satisfied by registration in and completion of courses deemed pertinent to the Ph.D. program by the students advisory committee and by the Graduate College, Office of Academic Affairs.

Transfer Credits

For master's degree programs, a maximum of nine semester hours taken elsewhere and not applied toward any earned degree, which were passed with grades of "B" or better, may be transferred, subject to the approval of the academic unit and the Graduate College, Office of Academic Affairs. Students who have completed their baccalaureate degree at IIT with course credits in excess of the number of hours required for that degree, which were not applied toward the baccalaureate degree, may also be allowed to transfer up to nine of those excess hours. Course credits in excess of the nine credit hours may be used for a degree program provided the credits were not applied toward a prior degree and the student has received the permission of the advisor, the academic unit head, and the Graduate College, Office of

Transferring from Another Program

A regular student planning to transfer from one degree program to another should discuss the matter with academic advisors in both programs. The student should

Program of Study

A graduate degree will be awarded upon the completion of a coherent program of study. Form G401 is the mechanism for outlining and obtaining approval of a coherent program and may be accessed and submitted online at www.iit.edu/graduate_college/academic_affairs/ Forms GradStu.shtml. Master's and doctoral students must file a program before completing nine credits of graduate study. However, doctoral students without a prior master's degree may file a program of study before completing 27 credit hours. After these deadlines, furAcademic Affairs prior to registering for any of the additional courses. Doctoral degree candidates may transfer previously completed graduate work not applied toward any prior earned degree, up to a maximum of 42 semester hours of credit beyond the baccalaureate degree (which may include up to 32 credits from a completed master's degree), or 50 percent of their total IIT 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 at IIT.

then submit an application for admission to the new department in the Office of Graduate Admission. The student will be notified once the decision is made.

ther registration may not be allowed until a program of study is approved by the Graduate College, Office of Academic Affairs. A graduate student will be assigned to a preliminary advisor when admitted as a regular student. An academic advisor will be officially assigned before the student's program of study is approved. The student may subsequently change advisors by filing the Change of Advisor Form, G410, online at www.iit.edu/graduate_college/academic_affairs/Forms GradStu.html.

Course Substitution

Once a student has filed a program of study, deviation from the program requires the same formal approval on a Revised Program of Study Form, G406, as the original plan of study. The Graduate College, Office of Academic Affairs may not approve changes in the program after the student has filed an application for graduation without the approval from both the academic advisor and

Credit by Examination

With the prior approval of their respective advisors, academic unit heads and the Graduate College Office of Academic Affairs, students may obtain credit for a course by paying athe published fee and taking a special examination. Credit by examination is limited to nine credits with grades of "A" or "B" and is subject to the limithe department chairman. Once a course on the program has been completed (i.e., grades have been issued), it may not be dropped to raise the program GPA required for graduation. The Revised Program of Study Form G406 can be accessed and submitted online at www.iit.edu/graduate_college/academic_affairs/Forms GradStu.shtml.

tations 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.

Academic Grades

The following grades are given to graduate students and count in calculating a student's cumulative GPA. 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 IIT are not included in computing the GPA. Students may access their grades online at my.iit.edu, under the academics tab.

Grade	Grade Points Per Credit Hour	Description
А	4	Excellent.
В	3	Performance at the level necessary for a graduate degree.
С	2	Performance below the overall level necessary for a graduate de- gree. Some academic units require students to repeat certain courses if the initial grade was a "C.'
D	1	Passing. Used for undergraduate students.
Ε	0	Unsatisfactory performance. This grade cannot be used to fulfill a graduate program requirement. If required in a program of study, the course must be repeated.
AU	N.A.*	Audit. No credit is given for an audited course and it is not used to calculate a student's GPA.
WP	N.A.*	Withdraw passing.
Ι	N.A.*	Incomplete.
NG	N.A.*	No grade due to non-attendance
WE	0	Withdraw failing.
S/U	N.A.*	Satisfactory or Unsatisfactory.
R	N.A.*	Research result pending

Incomplete ("I") Grades

The "I" grade indicates that the student's work to date is of passing quality but is incomplete for reasons acceptable to the instructor. The grade of "I" may be assigned only in the case of illness or for unusual or unforeseeable circumstances that were not encountered by other students in the class and that prevent the student from completing the course requirements by the end of the semester. "I" grades should not be used to allow a student to repeat a course. Prior to assignment of the "I" grade, the student and the instructor should agree on the work that needs to be completed. The work must be completed by no later than the end of the sixth week of class of the next regular (fall or spring) semester.

A grade of "I" will be removed with the approval of the department chair and the Graduate College, Office of Academic Affairs after all remaining work is completed and the instructor assigns a regular grade. If no regular grade has been received in the Office of Student Records and Registration by the deadline, the "I" grade will revert to a grade of "E." No exceptions will be granted except through appeal to the Graduate College, Office of Academic Affairs.

"R" Grades

In the case of research courses, courses numbered 591 and 691, the grade of "R" may be assigned for the reasons listed above and will remain until the student has satisfactoraly completed the course work. Once assigned, the grade of "R" will remain on the student's transcript

until the research as determined by the research professor is completed. "R" grades should be removed as soon as possible and no later than the start of the semester in which the student plans to graduate.

Non-Attendance "NG" Grade

A grade of NG is assigned by the course instructor when a student registers but does not attend a course in which he officially registered. A course must be dropped by the deadline for drop/add as published in the semester Academic Calendar to avoid financial penalty. The NG grade is not calculated in the GPA; however, the student forfeits the course tuition.

be changed to a legitimate letter grade.

in calculating the GPA.

quirements at IIT.

after the term has begun. Neither "WP" or "WE" can

demonstrate to his or her advisor, 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

Withdraw Passing ("WP") and Withdraw Failing ("WE") Grades

Withdraw passing ("WP") and withdraw failing ("WE") are grades issued to students who withdraw from a class

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

Audit ("AU")

In general, grades of "E", "I", "U", "WE", "WP", "NG", or "AU" cannot be used to fulfill the requirements of a graduate program. Auditing of courses is discouraged, but a student may do so if he or she has taken the necessary prerequisites, if the student's presence does not exclude a student who wishes to enroll for credit and if the student's presence does not distract from the conduct of the course as determined by the instructor. An auditor

must pay full tuition for the course but is not held for examinations and does not receive credit. Auditors may not change their registration to receive credit after the deadline posted in the Enrollment Guide. The "AU" grade issued for an audited course can never be changed, used for graduate credit, or for fulfillment of degree re-

Change of Grade

Once grades are posted by the registrar or instructor, grade changes can only be accomplished by a Change of Grade Form. The student's instructor must indicate the requested change, and give a reason as to why the change should be approved by the academic unit head. The approved form should be forwarded to the Graduate College, Office of Academic Affairs which will either reject the request and return the form to the academic unit, or approve the change and send the form to the registrar. No grade change is official until it is posted on the student's transcript by the registrar. Research ("R")

Repeating a Course

Students may repeat up to two distinct courses with each course being repeated once. Both grades will be recorded and the grade used in the calculation of the GPA will be the latest recorded. Re-registration to repeat a course will require the permission of the student's advisor, academic unit head, and the associate dean for academic affairs, and will also require completion of the

Residence Requirement

Degree-seeking graduate students are required to register every fall and spring semester unless they receive special permission in writing from the Graduate College, Office of Academic Affairs for a leave of absence. In addition, doctoral students must spend a minimum of one year of full-time study at IIT. (Students should consult the grades in thesis, project or special problem courses numbered 591, 594 and 691 remain on the student's record until changed by the instructor. A student receiving an incomplete in any other course must arrange with the instructor to change the grade before the end of the sixth week of the semester following the term in which the incomplete was granted. An incomplete will revert to an "E" and cannot be changed to a passing grade at a later date, unless approved by the course instructor, the academic unit head and Graduate College, Office of Academic Affairs.

"Course Repeat/Audit Form", or the G702 Probation Contract, when applicable. This form must be submitted at the time of registration and can be accessed online at www.iit.edu/registrar/registration_tools/pdfs/grad_ course_repeat.pdf. The original course grade earned will remain on the student's academic transcript.

definitions of a full-time student and credit requirements listed within this 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.

Time Limit to Complete a Degree

All requirements for a master's degree must be completed within the 12 semesters immediately preceding graduation. All requirements for a doctoral degree must be completed within twelve regular semesters after the approval of the program of study. If the twelve-semester deadline is not met, then a petition for extension must be filed by the student and the outdated courses listed on the student's program of study (Form G401) must be revalidated. The petition must include a detailed plan for the completion of the degree and be endorsed by the academic advisor and the academic unit head. The student's petition for extension must be presented before the

Class Attendance

All students are expected to attend their courses regularly. Excessive absences may cause a student to be dropped from the course at the discretion of the instructor, academic unit head and the Graduate College, Office of Academic Affairs. A dropped student receives a grade of "WP" or "WE" in the particular course. In time limit is reached. The Graduate College, Office of Academic Affairs will notify the student of their 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 IIT. A statement from the academic unit head indicating the list of courses on the student's program of study that are to be revalidated (Form G504) and the expected date for the revalidation must accompany the extension approval. The M.S. or Ph.D. comprehensive or thesis examination may serve the purpose of revalidating the outdated program of study.

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.

Master's and Doctoral 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 program of study. The examination may be oral, or written, or both. The academic unit determines the form, scope, and time of the examination. The master's thesis examination may serve as the comprehensive examination. The academic unit has the option of offering professional master's degrees with a minimum of 30 credit hours without requiring a comprehensive exam (i.e. coursework only). In the case of an oral examination, at least two Category I (tenure track) faculty members must be present to serve in the student's committee at the examination. One external, non-IIT or other faculty categories at IIT, committee member with voting privilege may be included with the approval of the Dean of the Graduate College. With the approval of the academic

Master's Thesis Examination

Once the preliminary draft of a master's thesis is prepared, the head of the student's academic unit will appoint a master's thesis committee, consisting of at least two or more Category I (tenure track) IIT faculty members. One external, non-IIT or other faculty categories at IIT, 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 advisor must recommend the external member to the Dean of the Graduate College. A resume should be attached to the recommendation. The thesis committee is responsible for approving the preliminary thesis draft using Form G501A, which the student brings

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-IIT or other faculty categories at IIT, 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 advisor 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

unit chair, the student's advisor 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 Graduate College 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 Graduate College, Office of Academic Affairs.

to the thesis examiner prior to the final oral examination. The form, scope, and time of the examination are determined by the academic unit. The examination result must be submitted on Form G303 at least 15 days prior to the last day of courses. The graduate student must be registered in the semester in which the examination is taken. A student who fails the thesis examination may repeat the examination once after a period of at least 30 days from the initial examination. Any additional consideration must be petitioned, supported by the academic unit and approved in writing by the Graduate College, Office of Academic Affairs.

> qualifying examination. A minimum of four Category I (tenure track) faculty members must participate in the oral portion of the examination.

- 3. The examination must be taken within the first year of Ph.D. study if the student has an M.S. degree.
- 4. All work for a doctoral degree must be completed within six calendar years after the approval of the program
- 5. The results of the qualifying examination must be submitted within fifteen days of the administration of the examination on Form G303 to the Graduate College, Office of Academic Affairs.
- 6. If the student fails the qualifying examination, the examining committee may recommend a reexamination. At least one semester of additional preparation is considered essential before reexamination. 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 Graduate College, Office of Academic Affairs.

Comprehensive Examination

After the approval of a program of study and within a period of time specified by the academic unit, the student must appear for the comprehensive examination. Though students typically take this examination at the end of the second year of Ph.D. study, the only time requirement is that the comprehensive examination is completed at least one year prior to the final thesis examination. The student must be registered in the semester in which the examination is taken. The proposal for Ph.D. dissertation is normally presented as part of the comprehensive examination. The following rules apply to the comprehensive examination:

- 1. The examination may be written, oral, or both.
- 2. A minimum of four Category I (tenure track) faculty are required for all examining committees of doctoral candidates. The chair and two other members from the committee must be from the student's major, and the fourth member must be from outside the student's major (e.g., MAE faculty may serve on an MSE student committee). One external, non- IIT or other faculty categories at IIT, 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 advisor 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 in the same academic unit. The role of the outside member of the committee is to provide an element in the examining committee function that is independent of the immediate interest of the academic unit in which the candidate is seeking his or her degree. The outside member of the committee has the responsibility of repre-

senting 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 coadvisors 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 appointed by the Graduate College, Office of Academic Affairs. The nominations must be received on Form G301A by the end of the second week of the semester in which the examination is going to be held. The Graduate College must be notified on Form G301A of the time and date of the comprehensive examination at least two weeks before the examination.
- 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 IIT. 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 Graduate College, Office of Academic Affairs. 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-IIT or other faculty categories at IIT, 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 advisor 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 cochairs 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 cochairs and voting members of the student's committee. The examining committee is nominated by the academic unit head and appointed by the Graduate College, Office of Academic Affairs by the second week of the semester in which the examination will be administered.
- 2. At least five weeks prior to commencement, the preliminary draft of the thesis must be approved on Form G501A by the committee and by the thesis examiner before the student's appearance for the oral examination. The oral examination will be canceled if the preliminary draft is not acceptable before the scheduled time for the oral examination.
- 3. Form G501A is to be signed by committee members as they receive the draft of the final copy of the dissertation prior to the defense and for review. The approval of Form G501A indicates that faculty members have received a copy of the dissertation and are willing to read and comment on it. The members of the committee are not allowed to share the content of the draft with any outside individuals without the permission of the committee chair. After the first submission of the dissertation, the thesis examiner checks Form G501A for signatures of committee members, and the academic unit head. The thesis examiner also checks the format, paper stock and pagination, and reviews

portions of the text for general usage, references and bibliographic form.

- 4. Upon final submission, the signature pages and the final thesis approval form (Form G501B) are checked by the thesis examiner for signatures of committee members, academic unit head and the Graduate College, Office of Academic Affairs. The signatures on Form G501B indicate that the committee members are satisfied with the content of the dissertation and no additional changes are required before its final submission to the Graduate College's Editorial Office. It is the responsibility of the student and the committee chair to notify the Graduate College of any changes in the structure of the examining committee. The same committee that approved the preliminary dissertation must also approve the final copy of the dissertation.
- 5. The examination is open to all faculty but only the appointed committee members may vote. The chair of the committee is responsible for the conduct of the examination. In addition, Form G301B must be received by the Graduate College, Office of Academic Affairs by the end of the second week of the semester in which the examination is going to be held. The Graduate College must be notified of the date and time of the final thesis examination at least two weeks before the examination using Form G301B. Examination results reported on Form 309 must be received in the Graduate College at least 15 days before commencement. One pdf copy on a CD and three paper copies of the completed dissertation must be deposited with the thesis examiner at least nine days before commencement.
- 6. A student who fails the thesis examination may be re-examined after a period of 30 days has elapsed. Students failing the examination twice will be asked to terminate their graduate study at IIT. 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 Graduate College, Office of Academic Affairs. 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 IIT Main Campus. Exceptions to this policy are made only for certain graduate students whose examinations are administered at other IIT campuses.

Completion of Studies and Graduation

As part of the requirements for the completion of graduate studies at IIT, each student must be admitted as a regular student, file and complete a program of study approved by the corresponding degree program officials and the Graduate College, Office of Academic Affairs. Ph.D. students must also pass the qualifying and comprehensive examinations, fulfill the residence requirement

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

Doctoral Candidates

Doctoral study must be completed within six years of the date of approval of the program of study. An extension will require an agreed upon schedule for the completion

Application for Graduation

Students expecting to graduate in a given semester must file an Application for Graduation (Form G527), online with the Graduate College, Office of Academic Affairs, by the deadline listed in the Academic Calendar for the semester of graduation. Late applications will be declined. Final revisions to the program of study must be filed by the graduation application deadline. 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 Graduate College, Office of Academic Affairs will check for completion of IIT's degree requirements. The diploma will be issued by the registrar after grades are reported, usually about four to six weeks after the end of the term.

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 and submit a dissertation before graduation. (Students should refer to the "Synopsis of Graduate Studies" at IIT portion of this bulletin for a list of steps and corresponding forms that must be completed, the detailed degree requirements listed under the relevant academic unit in this bulletin, and the information regarding program changes, for additional information).

may petition the Graduate College, Office of Academic Affairs for an extension. Any courses that fall outside the six-year time limit must be revalidated.

of remaining degree requirements. Any courses that fall outside the six-year limit must be revalidated.

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 good 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 is requested using form G701, Graduate Student Petition.

units and cannot be done in the IIT library. Registration for thesis research cannot fulfill a requirement for a nonthesis degree, unless a petition approved by the academic unit and the Graduate College, Office of Academic Affairs, subject to the limits of a project course (594) and the acceptable report of final project work, is filed and approved by the academic advisor, academic unit head, and the Graduate College, Office of Academic Affairs.

Change of Master's Thesis to Non-Thesis Option

In several majors, a master's degree may be earned without the preparation of a thesis. When changing from a thesis to non-thesis option, a student may transfer up to four hours of credit for satisfactorily completed Course 591 (Research and Thesis for the Master's Degree) to satisfy the requirement for Course 594 (Special Projects), provided that two conditions are met: first, the student's GPA must be at least 3.0/4.0; second, the student's academic unit must permit the change to a non-thesis option after consulting with the student's adviser and must approve the transfer on the grounds that the thesis-oriented work is equivalent to work on a project.

Procedures for evaluating the transfer of credits from 591 and 691 to 594 (and for evaluating the student's performance on the Special Project) must be documented and monitored by each academic unit. The graduate college will allow up to 4 credits of 591 or 691 to be converted to 594 credits.

To initiate a request to change from thesis to a non-thesis option, the student will complete a G403 Change of Degree, Major, or Specialization Form at www.iit.edu/graduate_college/academic_affairs/Forms GradStu.html.

Certificate Programs

A graduate certificate program (GCP) is defined as a group of three to five 400- and 500-level courses in a concentration within a department or program organized with the objective of training students in a specific area of expertise. Admission to a GCP is limited to students who qualify as non-degree graduate students who hold a bachelor's degree with a GPA of 2.5/4.0 or higher. The GRE is not required. Admission as a certificate student does not guarantee future admission to a graduate degree program.

Course requirements for a GCP are determined by the individual department, and must have a minimum of nine credit hours with at least one course at the 500 level. No more than nine credit hours of 400-level courses can be included; no more than half the credits or courses may be specialized (topical) accelerated courses. Transfer credit cannot be applied toward a graduate certificate.

Graduate Accelerated 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 Graduate College, Office of Academic Affairs.

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 Graduate College Office of Academic Affairs. All students who are required to submit a thesis for graduation must The time limit for its completion is three years. A student may complete more than one graduate certificate.

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 Graduate College, Office of Academic Affairs, and must be approved by that office and by the academic unit head.

The completion of a GCP will be indicated on the student's transcript. A certificate student who subsequently applies to and is admitted to a specific master's degree program may apply all approved coursework taken as a certificate student and passed with a "B" grade or better to the master's degree program.

No more than six credit hours of accelerated courses may be included in a master's degree program of study. Accelerated courses can be selectively included in a Ph.D. program of study at the rate of six credits per 32 course credits, and their inclusion is subject to approval of the adviser, academic unit head and the Graduate College, Office of Academic Affairs.

Students must register for the accelerated course before the first class session in order to receive credit for the course.

attend this meeting, which is open to all students, faculty, and staff. Graduate student theses must conform to the guidelines given in the latest IIT Thesis Manual, available online at www.iit.edu/graduate_college/ academic_affairs/Thesis_information.shtml.

Appointment With Thesis Examiner

All students submitting a thesis must make an appointment with the thesis examiner for the approval of the preliminary draft of their theses. The meeting with the thesis examiner must be scheduled at least six weeks before the end of the semester and prior to the thesis defense. At least five weeks before the end of the semester of graduation, all students submitting a thesis must make a second appointment with the thesis examiner for the

approval of the final draft.

The second meeting with the thesis examiner must take place after the thesis defense and the approval of the final draft by the thesis review committee.

Appointments may be made by calling 312.567.3024.

Letter of Completion

A student who has completed all the requirements for graduation may request a letter of completion from the graduate dean at any time during the semester. The student will not receive his or her diploma until grades are reported by the registrar, usually within five weeks after the end of the semester or term.

Transcript of Grades

Transcripts of grades are issued from the Office of the Registrar, 104 Main Building. Visit www.iit.edu/registrar/student_records/transcripts.shtml for information regarding this process. Requests for transcripts should be made at least 10 days prior to the date the transcript is needed and should include the student's ID number, dates of attendance and address where the transcript should be sent. During registration week, please allow additional time for processing transcripts. Transcripts will be released only after the student has fulfilled all financial obligations to the university. Students may view their transcripts online and may complete a transcript request form at www.iit.edu/registrar/. A fee of \$10 is charged for each transcript issued.

General Policies

Regulations Subject to Change

Regulations and policy guidelines are established by the Graduate Studies Committee, composed of the graduate dean and an elected representative from each graduate degree program on the Main Campus. Every attempt is made to keep this bulletin up to date; students, how-

Right of Appeal by Petition

A student should attempt first to resolve any departure from the stated rules with his or her advisor 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 advisor and the academic unit head to the Graduate College's Office of Academic Affairs explaining any extenuating circumstances and requesting a

Change of Records Information

Students must promptly advise the Graduate College, Registrar, and their respective academic units if they change their name, Social Security Number, mailing address or telephone number. Students may update their local, work, next-of-kin and e-mail addresses online at www.iit.edu/registrar go to

Standards of Conduct

Students are responsible for their own conduct; university regulations and requirements are published in the Student Handbook. Graduate students are subject to the rules and regulations published in this handbook. IIT reserves the right to terminate a student's

Code of 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 nonmatriculated 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.

ever, should consult the Graduate College's Office of Academic Affairs or the academic unit head for revisions and updates. The current version of the Graduate Bulletin is maintained on the Graduate College's Web site at www.iit.edu/graduate_college/bulletin/.

specific solution (waiver) with appropriate additional requirements that may develop. The written approval must be attached to Form G701, Graduate Student Petition. Form G701 will not be accepted without a prior approval of the academic advisor and the academic unit head, unless the conflict is unresolved between the student and the advisor or the academic unit head. The graduate dean's decision regarding the unresolved conflict is final.

Student Records Update/Personal Information. Any changes requested for name, permanent address or student identification number must be done in writing. Change of Information Forms are available at www.iit.edu/registrar/student_records/pdfs/ iit_personal_information_request.pdf

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 www.iit.edu/student_affairs/handbook.

- 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 before such material is revealed or distributed by the instructor.
- 5. Failure to abide by the instructions of an instructor or exam-proctor.
- 6. Hindering any member of the IIT community in his or her studies, research, or academic work.
- 7. Making material misrepresentation in any submission to or through any office of the university to a potential employer, professional society, meeting, or organization.
- 8. Knowingly making false accusation concerning academic honesty or giving false information to any authority investigating a violation of this code.

Note: Students in the Chicago-Kent College of Law are subject to the Chicago-Kent College of Law Code of Conduct.

Expenses and Financial Assistance

All University mandatory and non-mandatory charges are published regularly in official University publications including electronic mail and web site postings. For a complete listing of current tuition, fees, and other charges go to www.iit.edu/registrar/finance/, then select Tuition

Admission Application Fee

All first time applications for graduate admission must be accompanied by a non-refundable fee. Any applicant who has attended IIT previously, or who has already paid

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 School of Law and at Stuart School of Business charge different rates depending on the program. Consult the official University publications including electronic mail and web site postings for the latest charges.

Enrollment Deposit

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

Orientation Fee

First time graduate students are charged a one time fee to cover the costs of orientation activities for their first term of enrollment.

Other Fees & Charges

A student may incur other fees and charges that are both mandatory and non-mandatory. For a complete current listing of all charges and fees go to www.iit.edu/registrar/finance, then select Tuition and Fees. and Fees. The University regrets that continually rising costs do not permit it to guarantee that published charges will not change. Students and parents should anticipate periodic increases in the future.

an application fee to IIT, does not have to pay a second application fee. Please contact the appropriate program admissions office for any applicable fee.

No charge is made for seminars carrying no credit hours. For review or other noncredit 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 (9) credit hours or more are considered full-time. Graduate students registered for less than nine (9) credit hours are considered part-time.

Gainful Employment Information

As of July 1st 2011 institutions must disclose the following information about each of the institution's certificate programs that lead to gainful employment: the name of the certificate program, the CIP code, 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.

IIT's accreditor does not require the calculation of job placement rates and therefore we are unable to disclose such rates. Once the National Center of Education Statistics (NCES) publishes its methodology for calculating placement rates, IIT will use it to calculate such rates. Per Gainful Employment guidelines, if the number of students who completed a Gainful Employment program during the award year was less than ten (10), for privacy reasons the school cannot disclose median loan debt and on-time completion rate.

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

Books and Supplies

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 may spend less on books but substantially more on supplies.

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

Payment of all term charges to the University is due on the first day of classes of each term. For those unable to complete payment by that deadline there are several payment plan options available that incur additional plan fees. The latest information and costs and payment plan enrollment forms are at www.iit.edu/registrar/, select Finance. Failure to adhere to any payment plan schedule of payments will result in late fees in addition to any plan administrative fee. Payments may be made by cash, check, money order, or credit card. Credit card payments may be made at my.iit.edu, select IIT Web for Students, select Student & Credit Card Payment. Payment may also be made in person at the IIT Cashier's Office in the Main Building, Main Campus or at the Bursar's Office at the Downtown Campus. Payment by mail may be made by contacting the Bursar's Office at bursar@iit.edu; or at my.iit.edu, select "My Accounts" channel within the Finances tab.

Outstanding Debts

A restrictive hold is placed on a student's record when that student is delinquent in fulfilling his or her financial obligation to the University. A student will be considered delinquent when his or her account is not current according to established University policies and payment due dates. Students with outstanding University debts

University Refund 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 a refund or credit for unused tuition upon written request to the applicable program administrative office. Payments for other charges incurred may may be suspended from current term classes. Students whose accounts are not current will not be allowed to register or attend classes for any subsequent term. No diploma, certificates of attendance, letters of completion, or transcripts of academic records will be issued until all financial obligations have been met.

be the responsibility of the student at the determination of the University.

Students should consult http://iit.edu/bursar/credits_ and_refunds.shtml for the approved University refund schedule.

Student Health Insurance

All students who are either registered for 9 or more credit hours or occupants of IIT residence halls are required to purchase the basic student health insurance policy or to submit proof of equivalent insurance before the end of the first week of classes. All students who are here on an F1 or J1 visa and are registered for at least 1 class, participants in the co-op program, research or teaching assistants or occupants of IIT residence halls are required to purchase the basic student health insurance. The premium for the basic insurance will be added to student tuition and fees as a charge. To avoid this charge, submit proof of comparable coverage online at www.iit.edu/student_health/insurance/. F1 and J1 students may only waive IIT's coverage with proof of U.S. employer provided insurance. Once a waiver is accepted it will be valid through the student's continued enrollment at IIT. Other students, spouses, and dependents of students may participate in the student health program, if desired. Students should consult the Student Health Service in IIT Tower, Suite 3D9-1, at 312.567-7550, for further details.

Parking Fee

All students parking in campus parking lots must register their cars with IIT Parking Services and pay a parking fee at the beginning of the semester. For current fees, students should contact Parking Services at

Housing

The university offers two types of Housing: Residence Halls (furnished dormitories) for undergraduates and single graduate students and Graduate Apartments unfurnished apartments for married and single graduate students.

Applications are processed in the order in which they are received and will only be processed if the application is accompanied with the appropriate non-refundable deposit (accepted in the form of an international money order, personal check or Visa, Discover, or Master Card credit card.)

Residence Halls

Although residence hall rooms are furnished with twin size beds, desks, desk chairs, dressers, etc., students are required to provide their own blankets, pillows, towels, and bed linens.

McCormick Student Village (MSV)

Traditional dormitory style residence halls of approximately 20 rooms per floor share a centrally located common washroom facility. The average room is $10'9 \times 15'9$ and is double occupancy. Single occupancy rooms are not guaranteed.

MSV Room Rates for the 2012-2013 academic year range from \$5,546 to \$9,704. MSV Board Rates for the 2011-2012 academic year range from \$4,806 for a 14-meal plan to \$5,054 for an unlimited meal plan.

Participation in the university food program is required. MSV contracts do not cover winter break or summer housing. Students who wish to reside over the winter break and/or summer may apply for this option at an additional cost. See contract for details.

State Street Village (SSV)

State Street Village, a state-of-the-art residence complex,

www.iit.edu/~parking/ or 312-567-8968. Students authorized to park in IIT lots will receive a parking hangtag.

It is not to be assumed that sending an application with a deposit, or a fax, or an e-mail will guarantee a space. Only students who have actually received a room assignment confirmation will be guaranteed housing.

If the student arrives without a housing confirmation, he/she may have to contact Hostelling International to make arrangements for temporary housing while waiting for room to become available.

offers two types of furnished living arrangements - quad suites and apartments. The apartments are equipped with refrigerators, ranges and microwaves. Residents in quad suites are required to purchase meal plans. Participation in the university food program is optional for the SSV apartment residents.

SSV room rates for the 2011-2012 academic year range from \$8,156 to \$12,864. SSV Board Rates for the 2011-2012 academic year range from \$4,806 for a 14-meal plan to \$5,054 for an unlimited meal plan.

The SSV Academic contract rates include housing over the winter break. Summer housing option is available at an additional cost.

Gunsaulus Hall

Each studio, 1-bedroom, and 2-bedroom apartment features kitchen appliances, window treatments, and new flooring. Gunsaulus includes amenities such as campus cable, 5-digit dialing, internet access, and a community help desk. Gunsaulus Hall also includes two lounges located on the first floor.

Gunsaulus Hall room rates for the 2012-2013 academic

year range from \$6,560 to \$13,974.

Carman Hall

Carman Hall is a furnished apartment building for graduate students. A variety of apartments types are available, including studio and one-bedroom with den apartments. The apartments are available through a 10-month contract. Contracts are available August to May, with an option for an additional contract during the summer months. Based on availability, contracts can be renewed for consecutive academic terms. Carman

Temporary Off-Campus Housing

Temporary off-campus housing may be available at Hostelling International, 24 East Congress Parkway, three miles north of the university. Contact them at 312.360.0300 or www.hichicago.org for information.

The student must have a signed housing contract with

Financial Aid

Student Eligibility Requirements to Receive Federal Financial Assistance

Students must be U.S. citizens or eligible non-citizens and be enrolled in a degree-seeking program for at least half-time (five credit-hours or more per term).

Comprehensive Financial Aid Program

IIT administers a comprehensive financial aid program, which includes federal and private funds for both full and part-time students. Federal programs include loans and work-study employment. IIT uses the formula established by the U.S. Congress to determine financial need for assistance. IIT offers limited academic scholarship assistance to graduate students. These scholarships are

Determining Financial Need for Assistance

Financial need is the difference between a student's total annual cost of attending IIT and the amount the student is expected to contribute toward the cost of attendance. The total cost of attendance at IIT includes tuition and mandatory fees, room and board, books and supplies, transportation and personal expenses. The amount that the student is expected to contribute is called the Ex-

Application Process

All students applying for financial assistance need to complete the Free Application for Federal Student Aid (FAFSA). This application is available after January 1st at www.fafsa.ed.gov and should be filed by the student as soon as possible after January 1st of the academic year in which the student is planning to enroll. (The IIT School Code is 001691). The priority date for campus-based federal aid (Federal Perkins Loan and Federal Work Study) Hall will be closed for fall 2012, re-opening spring 2013.

Carman Hall room rates for the 2012-2013 academic year range from 5,904 to 14,802.

Resident participation in a meal plan is not required.

* These rates are subject to change. Please visit www.iit.edu/housing/ for current rates, deadlines and other housing information.

IIT in order to stay in university housing. If he/she arrives on campus without a room confirmation, housing is not guaranteed. Contact Hostelling International if you need a place to stay while you complete the housing process.

awarded by the individual IIT departments. Private loans are also available and are based on credit approval from the lender.

For the most up-to-date information, visit the office of Financial Aid online at www.iit.edu/financial_aid/.

pected Family Contribution (EFC) and is calculated by a formula determined by the U.S. Congress. After the EFC is subtracted from the cost of attendance, the remainder is considered to be demonstrated need for financial assistance. One of the principles of need-based assistance is that students are expected to help pay some of the cost of attendance.

at IIT is April 15th. All financial assistance is awarded on an annual basis. Students interested in receiving federal aid must complete a FAFSA each year, beginning January 1st. The amount of financial aid that a student receives each year depends on demonstrated need and the availability of funds. Students applying for financial aid may be required to submit tax information upon request.

Federal Financial Aid Programs

Federal Work Study Program

Federal Work Study provides opportunities for students to work on or off-campus. Both undergraduate and graduate students with demonstrated financial need may be eligible to participate in this program. Students awarded work study funds can earn money to help pay educational expenses. On campus jobs are advertised at http://www.iit.edu/financial_aid/student_employment/. Off-campus jobs will be private, nonprofit organizations or public agencies that encourage community service work. Off-campus jobs are also advertised by the Career Management Center (www.cmc.iit.edu). This office assists students in finding summer employment and permanent jobs after graduation.

Federal Direct Loan Program

The Federal Direct Loan Program includes the Unsubsidized stafford and PLUS loan programs for graduate students. The Stafford Loan Program provides low-interest loans to assist students with paying educational costs. The interest rate for new loans is set on July 1 and is fixed. These loans must be repaid over a period of time after a student leaves school.

The Unsubsidized Stafford Loan is not awarded based on demonstrated need and interest is charged from the time that the loan funds are disbursed to the student. Students have the option of paying the interest or having the interest added onto the principal. Fees of up to 4 percent are charged on each loan, and are deducted before the funds are applied to the student's account.

Continued Eligibility for Financial Assistance

All students receiving federal financial aid funds must demonstrate reasonable academic progress toward graduation from IIT. Reasonable academic progress includes satisfactory cumulative grade point average and sufficient

Applying for a Financial Assistantship

A fellowship provides financial support to defray the cost of tuition and a stipend for living expenses. A tuition scholarship (TS) provides all or part of the tuition only. Both are exempt from federal income taxes. Most degree programs provide financial support for teaching assistants (TA) who help with instruction, and research assistants (RA) who work on funded research projects. Graduate assistants (GA) receive partial support in the form of a stipend with no tuition support.

Only full-time students are eligible for assistantships. New students will be considered for fellowships, assistantships and scholarships when they apply for admission and will be notified of the award with the admission decision or shortly thereafter. Continuing students should apply to their major academic unit. The Graduate College administers a number of fellowships and scholarships but does not directly administer assistantships available to students in each academic unit. Acceptance of an

Additional Information

All financial aid awards for graduate students (excluding law and business students) are processed by the IIT Office of Financial Aid. Students should submit all information regarding financial assistance to: Office of Financredit hours earned each semester toward the completion of a degree program. Failure to comply with IIT's Reasonable Academic Progress Policy will lead to the student's losing eligibility for federal financial assistance.

award or appointment for the fall semester is considered binding on the student after April 15. If a student's academic work is judged to be unsatisfactory, the award may be canceled at the discretion of the university at anytime during the period covered.

Although an outstanding international student may receive some kind of award from IIT, most students must provide independent finances for their first year of graduate study. International students who are not recommended for an assistantship that would cover both tuition and stipend are required to carry at least nine credit hours per semester in order to maintain their F-1 student visa status.

Please Note: The tuition scholarship, plus any loan eligibility cannot exceed attendance cost for the academic year. Previously awarded loans may be adjusted after tuition scholarship notification.

cial Aid, 3300 South Federal Street, Chicago, IL 60616 (telephone 312.567.7219). The office is open from 8:30 am to 5pm, Monday through Friday, and may be found online at www.iit.edu/financial_aid/.

Alumni Tuition Benefit (ALUMED)

ALUMED is a tuition discount program for graduates of IIT or Midwest College of Engineering (MCE) who are pursuing graduate studies. Alumni registering as a degree-seeking graduate students, either part-time or full-time, will receive an alumni discount equal to one credit hour, at the current main campus graduate student tuition rate, each semester of enrollment. Alumni meeting any of the following conditions do not qualify for the discount:

• Alumni admitted to a graduate program as a nondegree seeking student

Dean's Scholarship for Full-time Alumni

Provides a half-tuition scholarship (maximum 9 credits total) during the first year of graduate studies at IIT. Available to any student who graduated from IIT within the past 2 years with an undergraduate GPA of at least 3.5 out of 4.0, enrolling in a full-time graduate program in the College of Architecture, the College of Science and

Part-Time Employment

Part-time employment opportunities may be available for students, both on- and off-campus. Positions include Federal Work Study jobs, career related co-ops and internships, or part-time and seasonal work. Co-ops, internships, and on-campus jobs are posted in the Career Management Center (CMC) e-Recruiting database. Other on-campus jobs may be announced directly by individual university departments. Students interested in and eligible for employment off-campus in their field of study can get job search assistance from the CMC and must attend an Introduction to Cooperative Education and Internship workshop conducted by the CMC.

Veterans' Educational Benefits

Veterans enrolling for the first time should obtain Veterans Affairs application forms from the Office of Student Records and Registration, Room 104, Main Building 312.567.6742. The university's Veterans Affairs representative processes subsequent enrollment certifications. For further information on veterans benefits, or to request an application, please visit www.enrollment.iit.edu and click on Registrar's Office. The veteran must also inform the Veterans Affairs representative of any change

- Alumni awarded a research or teaching assistantship
- Alumni registering as new students in a Chicago-Kent degree program
- Alumni participating in short courses, special programs, research, thesis, internship, coop and noncredit courses
- Alumni registered in undergraduate courses

This discount is administered by the Office of Graduate Admissions and awarded during the admissions process. Questions may be directed to gradstu@iit.edu.

Letters, the School of Applied Technology, or the College of Psychology.Armour College of Engineering excludes all but one department. This scholarship does not apply to IIT alumni pursuing a second or additional graduate degree.

Workshop schedules are posted at www.cmc.iit.edu. Appointments for individual career counseling may be made by calling 312.567.6800.

International students (on F1 visa) are restricted to oncampus employment for their first academic year of study at any school in the United States. After completing one academic year in the United States, students on F1 visa may be eligible for employment opportunities offcampus through the Cooperative Education or Internship Programs.

in credit hours within a term or of future enrollment plans. If a veteran drops a course or withdraws from school completely, his or her allotment may be reduced or withdrawn. The veteran must report immediately the exact termination date to the Veterans Affairs representative. Veterans must maintain reasonable academic progress according to university standards. Failure to meet minimum-progress criteria can result in a cessation of educational benefits.

Department of Applied Mathematics

208 Engineering 1 Building The Department of Applied Mathematics puts mathe-10 W. 32nd St. matics to work solving problems in science, engineering Chicago, IL 60616 and society. Applied mathematicians investigate a wide 312.567.8980 variety of topics, such as how to construct methods 312.567.3135 fax for multi-criteria decision making (requiring discrete www.math.iit.edu mathematics and statistics), predicting how financial markets will behave (requiring probability/statistics, Chair: analysis and optimization), and understanding how Fred J. Hickernell liquids flow around solids (requiring computational methods and analysis). **Director. Graduate Studies:** Xiaofan Li Our programs focus on four areas of modern applied mathematics: applied analysis, computational mathematics, discrete applied mathematics, and stochastics. More detailed descriptions of these areas follow.

Degrees Offered

Master of Science in Applied Mathematics Doctor of Philosophy in Applied Mathematics Master of Mathematical Finance (collaborative program with the Stuart School of Business)

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

Research and Program Areas

The research and teaching foci of the Department of Applied Mathematics at IIT are primarily in four areas of modern applied mathematics: applied analysis, computational mathematics, discrete applied mathemat-

Applied Analysis

Applied analysis is one of the foundations for interdisciplinary applied mathematics. The principles of (functional) analysis are applied to such areas as partial differential equations, dynamical systems, and numerical analysis.

The basic framework, concepts, and techniques of modern mathematical analysis are essential for modeling, analysis, and simulation of complicated phenomena in engineering and science. Applying the ideas and methods of modern mathematical analysis to such problems has been a thoroughly interdisciplinary effort. Doctor of Philosophy in Collegiate Mathematics Education (joint program with the Department of Mathematics and Science Education)

also has a 128-core computer cluster for research purposes.

ics, and stochastics. These areas are briefly described in the following subsections; faculty with primary and secondary interests.

Research and teaching within the applied analysis group at IIT concentrates on development and application of new techniques for investigating numerous phenomena in engineering and science. In particular, members of the group do research in nonlinear dynamics, approximation theory, numerical analysis, fluid dynamics, materials science, viscoelastic and polymeric fluid flows, biological science, quantum mechanics and electro-dynamics, solid mechanics, financial engineering, and other disciplines.

Primary interests: Bielecki, Duan, Edelstein, Lubin Secondary interests: Cialenco, Fasshauer, S. Li, X. Li, Nair, Rempfer, Tier

Computational Mathematics

The use of computation/simulation as a third alternative to theory and experimentation is now common practice in many branches of science and engineering. Many scientific problems that were previously inaccessible have seen tremendous progress from the use of computation (e.g., many-body simulations in physics and chemistry, simulation of semi-conductors, etc.). Researchers and scientists in these areas must have a sound training in the fundamentals of computational mathematics and become proficient in the use (and development) of new algorithms and analytical techniques as they apply to modern computational environments.

Research and teaching within the computational mathematics group at IIT concentrates on basic numerical

analysis, as well as development of new computational methods used in the study and solution of problems in the applied sciences and engineering. In particular, members of the group do research on complexity theory, the finite element method, meshfree methods, multiscale and multilevel methods, Monte Carlo and quasi-Monte Carlo methods, numerical methods for deterministic and stochastic ordinary and partial differential equations, computational fluid dynamics, computational materials science, computer-aided geometric design, and parallel computation.

Primary interests: Fasshauer, Hickernell, S. Li, X. Li, Tier

and mathematical biology, intersection graphs and their

applications, discrete location theory, voting theory applied to data analysis, graph drawing, random geometric

graphs, communication networks, coding theory, low

discrepancy sequences, algorithm design, and analysis.

Secondary interests: Duan, Rempfer

Discrete Applied Mathematics

Discrete applied mathematics is a fairly young branch of mathematics and is concerned with using combinatorics, graph theory, optimization, and portions of theoretical computer science to attack problems in engineering, as well as the hard and soft sciences.

Research interests in the discrete applied mathematics group at IIT are in discrete methods in computational

Primary interests: Ellis, Kaul, Pelsmajer, Reingold Secondary interests: Hickernell, Kang, Weening

Stochastics

Stochastics at IIT includes traditional statistics (the methods of data analysis and inference) and probability (the modeling of uncertainty and randomness). However, also included are other areas where stochastic methods have been becoming more important in recent years such as finite and infinite dimensional stochastic processes, stochastic integration, stochastic dynamics, stochastic partial differential equations, probabilistic methods for analysis, mathematical finance and discrete mathematics, computational methods for stochastic systems, etc. The current research and teaching interests in the stochastic analysis group at IIT include asymptotics in statistics, experimental design, computational statistics, stochastic calculus and probability theory, stochastic dynamical systems, stochastic control, stochastic partial differential equations, and statistical decision theory.

Primary interests: Adler, Bielecki, Cialenco, Duan, Hickernell, Kang, Tier Secondary interests: Ellis, Kaul

Faculty

Adler, Andre, Associate Professor. B.S., State University of New York-Binghamton; M.S., Purdue University; Ph.D., University of Florida. Asymptotics in statistics, probability, and statistical inference.

Bielecki, Tomasz R., Professor. M.Sc., Ph.D., Warsaw School of Economics. Mathematical finance, stochastic control, stochastic analysis, probability and random processes, quantitative methods for risk management in finance and insurance.

Cialenco, Igor, Assistant Professor. B.S., Ph.D., Moldova State University; M.S., Ph.D., University of Southern California. Stochastic processes, stochastic partial differential equations(PDEs), statistical inference for stochastic PDEs, application of stochastic PDEs to mathematical finance, operator theory, spectral analysis of non-selfadjoint operators.

Duan, Jinqiao (Jeffrey), Professor. B.S., Wuhan University (China); M.S., University of Massachusetts-Amherst; Ph.D., Cornell University. Stochastic dynamical systems; stochastic partial differential equations; nonlinear dynamical systems; modeling, analysis, simulation and prediction of random, complex and multiscale phenomena in engineering and science (geophysical and environmental systems, etc).

Edelstein, Warren, Professor. B.A., Lehigh University, M.A., Duke University; Ph.D., Brown University. Analysis of linear viscoelasticity and nonlinear creep, numerical analysis of flow-induced vibrations in tubes conveying fluids, numerical solution of boundary value problems arising in the quantum mechanics of semiconductors. Computational mechanics and mathematics of finance.

Ellis, Robert B., Associate Professor. B.S., M.S., Virginia Tech; Ph.D., University of California-San Diego. Combinatorics, spectral, random and algebraic graph theory, probabilistic methods, coding theory, and combinatorial algorithms.

Erickson, John F., Lecturer. B.S., M.S., University of Illinois-Chicago; M.S., Northeastern Illinois University; Ph.D., Illinois Institute of Technology.

Fasshauer, Gregory, Professor, Associate Chair, and Director of Undergraduate Studies, Department of Applied Mathematics. Diplom, Universitat Stuttgart (Germany); M.A., Ph.D., Vanderbilt University. Approximation theory, numerical analysis, meshfree methods with applications to multivariate scattered data approximation and the solution of partial differential equations. Computer-aided geometric design and bivariate splines.

Feng, Hualong, Visiting Assistant Professor. B.E., Beijing Institute of Post and Telecom (China); M.S., Southern Illinois University; Ph.D., University of Michigan. Hickernell, Fred J., Professor and Chairman. B.A., Pomona College; Ph.D., Massachusetts Institute of Technology. Computational mathematics, numerical approximation of integrals and functions, Monte Carlo and quasi-Monte Carlo methods, low discrepancy analysis, information-based complexity theory, design of laboratory and computer experiments, computational finance.

Ivanov, I. Ginchev, Visiting Professor. M.S., University of Wroclaw (Poland); Ph.D., Warsaw University of Technology (Poland). Real and complex analysis, functional analysis, convex analysis, optimization.

Kang, Lulu, Assistant Professor. B.S., Nanjing University (China); Ph.D., Georgia Institute of Technology. Non-parametric statistical modeling, Bayesian experimental design, computer experiments, engineering statistics.

Kaul, Hemanshu, Associate Professor. B.Sc., St. Stephen's College (India); M.Sc., Indian Institute of Technology (India); Ph.D., University of Illinois, Urbana-Champaign. Graph theory and combinatorics, discrete optimization and operations research, probabilistic models and mthods in discrete mathematics.

Li, Shuwang, Assistant Professor. B.E., TongJi University (China); M.S., Ph.D., University of Minnesota. Computational materials science and modeling of biosystems, numerical analysis, methods for interface problems in Fluids, Biology and Materials.

Li, Xiaofan, Associate Professor, Director of Graduate Studies in the Department of Applied Mathematics, and Associate Dean of Graduate Admission. B.A., Zhejiang University (China); M.A., Ph.D., University of California-Los Angeles. Computational fluid dynamics, computational materials science, boundary integral method, moving-boundary value problems, suspension of particles, phase transformation in materials science.

Lubin, Arthur, Associate Professor. B.S., Michigan State University; M.A., Ph.D., University of Wisconsin. Commuting contractions in Hilbert space, spectral theory, models for analytic functions, linear system theory.

Maslanka, David, Senior Lecturer. B.A., St. Xavier University; M.S., Ph.D., Illinois Institute of Technology.

Nair, Sudhakar E., Professor of Mechanical and Aerospace Engineering and Applied Mathematics. B.Sc., Regional Engineering College (India); M.E., Indian Institute of Science; Ph.D., University of California-San Diego. Solid mechanics, stress analysis of composite and inelastic material, dynamics of cable, fracture mechanics and wave propagation theory.

Faculty (continued)

Nieweglowski, Mariusz, Visiting Assistant Professor.

Pelsmajer, Michael J., Associate Professor. B.A., Williams College; M.S., Ph.D., University of Illinois, Urbana- Champaign. Discrete Applied Mathematics: Graph theory, combinatorics, communication networks, algorithms and complexity.

Rempfer, Dietmar, Professor of Mechanical and Aerospace Engineering and Applied Mathematics, and Associate Dean, Armour College of Engineering. M.S., Ph.D., Habilitation, Universität Stuttgart. Fluid mechanics, especially theoretical studies of transitional and turbulent shear flows in open systems, numerical fluid mechanics, modeling for environmental and urban fluid mechanics, coherent structures in turbulent flows, control of transitional and turbulent wall layers, nonlinear dynamical systems. Tier, Charles, Senior Lecturer. Ph.D. Courant Institute, New York University. Asymptotic and singular perturbation methods, applied stochastic modeling, mathematical biology, queueing models, computational finance.

Weening, Fred, Senior Lecturer. B.S., Carnegie-Mellon University; Ph.D. University of California-San Diego. Complex analysis, combinatorics.

Admission Requirements

- Cumulative undergraduate GPA minimum: 3.0/4.0 GRE score minimum:
- M.S.: 304 (quantitative + verbal) 2.5 (analytical writing)
- Before 2011: 1100 (quantitative + verbal)
- Ph.D.: 304 (quantitative + verbal) 3.0 (analytical writing)
- Before 2011: 1100 (quantitative + verbal)
- TOEFL minimum: 80/213/550 (internet/computer/paper based test scores)
- At least two letters of recommendation

Admission to the professional master's program in Mathematical Finance requires a bachelor's degree in mathematics, engineering, or equivalent, with a minimum cumulative GPA of 3.0/4.0. TOEFL scores (if required) must have a minimum score of 100/250 (internet/computer-based test score). A professional statement of goals/objectives (2 pages) and a curriculum vitae must be submitted. Three letters of recommendation are required (at least two must be from academia, the third may be from industry). An interview may also be required.

Typically, admitted students score at least 156 on the quantitative portion of the GRE and at least 3.0 on the analytical writing portion. However, meeting the

minimum or typical GPA test-score requirements does not guarantee admission. GPA and test scores are just two of several important factors considered for admission to the program, including grades in mathematics courses, letters of recommendation, and the student's overall record of achievements.

Admission to the Master of Science and the Ph.D. Program normally requires a bachelor's degree in mathematics or applied mathematics. Candidates whose degree is in another field (for example, computer science, physics, or engineering) and whose background in mathematics is strong are also eligible for admission and are encouraged to apply. Candidates in the Ph.D. program must also have demonstrated the potential for conducting original research in applied mathematics. Students must remove deficiencies in essential undergraduate courses that are prerequisites for the degree program, in addition to fulfilling all other degree requirements.

The director of graduate studies serves as temporary academic advisor for all newly admitted graduate students until an appropriate faculty member is selected as the advisor. Students are responsible for following all departmental procedures, as well as the general requirements of the Graduate College.

Masters in Mathematical Finance

Collaborative Program with the Stuart School of Business

Total Credit Hours: 33

The objective of the MMF 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 (SSB) and the Applied Mathematics Department (AM) and as such, it gives students the chance to benefit from the strength of both units. Students are required to complete a total of 11 semester courses, including eight core courses and three elective courses.

Core Courses

- MSF 505 Futures, Options and OTC Derivatives
- MSF 526 Computational Finance
- MSF 575 C++ with Financial Applications
- MATH 542 Stochastic Processes
- MATH 548 Mathematical Finance I
- MATH 565 Monte Carlo Methods in Finance
- MATH 582 Mathematical Finance II
- MATH 586 Theory and Practice of Fixed Income Modeling

Elective Courses from the Department of Applied Mathematics

CS 522 Data Mining

- MATH 512 Partial Differential Equations
- MATH 522 Mathematical Modeling
- MATH 540 Probability
- MATH 543 Introduction to Stochastic Analysis
- MATH 544 Stochastic Dynamics
- MATH 545 Stochastic Partial Differential Equations
- MATH 546 Introduction to Time Series
- MATH 566 Multivariate Analysis
- MATH 567 Advanced Design of Experiments
- MATH 569 Statistical Learning
- MATH 577 Computational Mathematics I
- MATH 578 Computational Mathematics II
- MATH 579 Complexity of Numerical Problems
- MATH 587 Theory and Practice of Modeling Credit Risk and Credit Derivatives
- MATH 589 Numerical Methods for PDEs
- MATH 590 Meshfree Methods

Elective Courses from the Stuart School

- MSF 524 Models for Derivatives
- $\begin{array}{ccc} {\rm MSF~525} & {\rm Interest} \ {\rm Rates}, \ {\rm Term} \ {\rm Structure} \ {\rm and} \ {\rm Credit} \\ {\rm Models} \end{array}$
- ${\rm MSF}~545 \ \ {\rm Structured} \ {\rm Fixed} \ {\rm Income} \ {\rm Portfolios}$
- ${\rm MSF}~546~~{\rm Quantitative~Investment~Strategies}$
- MSF 554 Market Risk Management
- MSF 555 Credit Risk Management
- MSF 556 Enterprise Risk Management
- MSF 564 Financial Theory
- MSF 565 International Finance Theory
- MSF 566 Financial Time Series Analysis
- MSF 567 Bayesian Econometrics
- MSF 574 .NET and Database Management
- MSF 576 OOP and Algorithmic Trading Systems
- MSF 577 High Frequency Finance
- MSF 584 Equity and Equity Derivatives Trading
- MSF 585 Fixed Income Options & Securities
- MSF 586 Advanced Options Trading

Core Requirement

All Mathematical Finance students must complete the eight core classes unless they have obtained written permission from their academic advisor 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 advisor.

Electives

At least one elective must be taken in Finance and at least one elective must be taken in Math from the elective options listed above.

Free Electives

One graduate level elective may be taken from outside the courses prescribed above, provided that it is consistent with the MMF program objectives and has been approved by the Program Director prior to the student's registration.

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

Total Credit Hours: 32 Thesis Comprehensive exam (Certification)

The M.S. degree program provides a broad background in the fundamentals of the advanced mathematics that is applied to solve problems in other fields. The goal is to prepare students for careers in industry and for the doctoral program.

Required Credit Hours

Required courses 12 hours Research/thesis 1-5 hours Elective courses 15-19 hours

Required Courses

A Master's thesis (up to 5 credit hours of MATH 591), under the supervision of a faculty member, the colloquium/seminar course MATH 593 (must take it at least twice with satisfactory grade), and at least two of the basic sequences in the four core areas of study:

Applied Analysis

MATH 500 Applied Analysis I MATH 501 Applied Analysis II

Discrete Applied Mathematics

MATH 553 Discrete Applied Mathematics I MATH 554 Discrete Applied MathematicsII

Computational Mathematics

MATH 577 Computational Mathematics I MATH 578 Computational Mathematics II

Stochastics

MATH 540 Probability

AND one of the following:

MATH 543 Stochastic AnalysisMATH 544 Stochastic DynamicsMATH 545 Stochastic Partial Differential Equations

Elective Courses

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.

The comprehensive examination requirement is fulfilled by achieving certification in two of the core areas of study. For procedures governing the certification process, the student should consult the current department regulations.

Doctor of Philosophy in Applied Mathematics

Total Credit Hours: 84 credit hours beyond the bachelor's degree Qualifying exam Comprehensive exam Dissertation and Defense

Required Credit Hours (if entering with a bachelor's degree)

Required courses 18 hours Research/dissertation 24-32 hours Elective courses 34-42 hours

Required Credit Hours (if entering with a master's degree)

Required courses 18 hours Research/dissertation 24-32 hours Elective courses: 2-10 hours

The Ph.D. program provides advanced education through coursework (including independent study) and original, creative research in order to prepare students for careers in industrial research and academia. The program requires a total of 84 credit hours (approximately 52 for students entering with a master's degree).

The qualifying examination requirement is fulfilled by passing written tests in three of the four core areas of study listed under the M.S. degree. The areas are chosen by the student and the qualifying exam must be completed within athe first five semesters of study (within the first three semesters for students entering with a master's degree in mathematics or applied mathematics. The written tests will be offered twice every year, one in the early Fall (September) and the other in early Spring (January or February). The tests are given in each area separately and students can take the tests in one, two, or three areas each time. The comprehensive examination consists of an oral examination based on the student's research proposal. The exam aims to ensure that the student has the background to carry out successful research in his/her chosen area and the proposed research has sufficient scholarly merit. Exceptions to these general rules require approval by the departmental Graduate Studies Committee.

Besides the courses in the core areas of study, the remaining courses in the program are selected in consultation with the student's academic advisor. The program may include at most three MATH courses at the 400-level. The program requires the student take the colloquium/seminar course MATH 593 at least six times with satisfactory grade. The program must include at least three (but no more than five) 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 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 32. An oral examination in defense of the thesis constitutes completion of the degree.

Doctor of Philosophy in Collegiate Mathematics Education

(Joint Program with the Department of Mathematics and Science Education) Details of this Ph.D. program may be found under the Department of Mathematics and Science Education in this Bulletin.

Course Descriptions

MATH 400

Real Analysis

Real numbers, continuous functions; differentiation and Riemann integration. Functions defined by series. Prerequisite(s): [(MATH 251)] (3-0-3)

(0 0 0)

MATH 402

Complex Analysis

Analytic functions, conformal mapping, contour integration, series expansions, singularities and residues, and applications. Intended as a first course in the subject for students in the physical sciences and engineering.

Prerequisite(s): [(MATH 251)] (3-0-3)

MATH 405

Introduction to Iteration & Chaos

Functional iteration and orbits, periodic points and Sharkovsky's cycle theorem, chaos and dynamical systems of dimensions one and two. Julia sets and fractals, physical implications.

Prerequisite(s): [(MATH 251, MATH 252, and MATH 332) OR (MATH 251, MATH 252, and MATH 333)] (3-0-3)

MATH 410

Number Theory

Divisibility, congruencies, distribution of prime numbers, functions of number theory, diophantine equations, applications to encryption methods. Prerequisite(s): [(MATH 230)]

(3-0-3)

MATH 420

Geometry

The course is focused on selected topics related to fundamental concepts and methods of Euclidean geometry in two and three dimensions and their applications with emphasis on various problem-solving strategies, geometric proof, visualization, and interrelation of different areas of mathematics. Prerequisite: Permission of instructor.

(3-0-3)

MATH 425

Statistical Methods

Concepts and methods of gathering, describing and analyzing data including basic 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 students in education or the social sciences. This course does not count for graduation in any mathematics programs. Credit not given for both MATH 425 and MATH 476. Course does not satisfy graduation requirements for Applied Mathematics majors.

(3-0-3)

MATH 426

Statistical Tools for Engineers

Descriptive statistics and graphs, probability distributions, random sampling, independence, significance tests, design of experiments, regression, time-series analysis, statistical process control, introduction to multivariate analysis. Same as CHE 426. Credit not given for both Math 426 and CHE 426 Course does not satisfy graduation requirements for Applied Mathematics majors. Requires sophomore standing. (3-0-3)

MATH 430

Applied Algebra

Relations; modular arithmetic; group theory: symmetry, permutation, cyclic, and abelian groups; group structure: subgroups, cosets, homomorphisms, classifications theorems; rings and fields. Applications to crystallography, cryptography, and check-digit schemes.

Prerequisite(s): [(MATH 230) OR (MATH 332)] (3-0-3)

MATH 431

Applied Algebra II

Ring homomorphisms; factorization and reducibility in polynomial rings; integral domains; vector spaces; fields and their extensions. As time permits, application to one or more of the following: Frieze and crystallographic groups, Caley digraphs, and coding theory. Prerequisite(s): [(MATH 430)]

(3-0-3)

MATH 435

Linear Optimization

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 granted for both MATH 435 and MATH 535.

Prerequisite(s): [(MATH 332)] (3-0-3)

MATH 453

Combinatorics

Permutations and combinations; pigeonhole principle; inclusion-exclusion principle; recurrence relations and generating functions; enumeration under group action. Prerequisite(s): [(MATH 230)] (3-0-3)

MATH 454

Graph Theory & Applications

Graph theory is the study of systems of points with some of the pairs of points joined by lines. Sample topics include: paths, cycles and trees; adjacency and connectivity; directed graphs; Hamiltonian and Eulerian graphs and digraphs; intersection graphs. Applications to the sciences (computer, life, physical, social) and engineering will be introduced throughout the course. Credit will not be granted for both MATH 454 and MATH 553

Prerequisite(s): [(MATH 230 and MATH 251) OR (MATH 230 and MATH 252)] (3-0-3)

MATH 461

Fourier Series & Boundary-Value Problems

Fourier series and integrals. The Laplace, heat, and wave equations: Solutions by separation of variables. D'Alembert's solution of the wave equation. Boundary-value problems. Prerequisite(s): [(MATH 251 and MATH 252)] (3-0-3)

MATH 474

Probability & Statistics

Elementary probability theory including discrete and continuous distributions, sampling, estimation, confidence intervals, hypothesis testing, and linear regression. Credit not granted for both MATH 474 and MATH 475. Course does not satisfy graduation requirements for Applied Mathematics majors.

Prerequisite(s): [(MATH 251)] (3-0-3)

MATH 475

Probability

Elementary probability theory; combinatorics; random variables; discrete and continuous distributions; joint distributions and moments; transformations and convolution; basic theorems; simulation. Credit not granted for both MATH 474 and MATH 475. Prerequisite(s): [(MATH 251)] (3-0-3)

MATH 476

Statistics

Estimation theory; hypothesis tests; confidence intervals; goodness-of-fit tests; correlation and linear regression; analysis of variance; nonparametric methods. Prerequisite(s): [(MATH 475)]

(3-0-3)

MATH 477

Numerical Linear Algebra

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 477 and MATH 577.

Prerequisite(s): [(MATH 350)] (3-0-3)

MATH 478

Numerical Methods for Differential Equations

Polynomial interpolation; numerical integration; 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 478 and MATH 578. Prerequisite(s): [(MATH 350)] (3-0-3)

MATH 481

Introduction to Stochastic Processes

This is an introductory course in stochastic processes. Its purpose is to introduce students to a range of stochastic processes which are used as modeling tools in diverse fields 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. Credit will not be granted for MATH 481 and 542.

Prerequisite(s): [(MATH 332 and MATH 475) OR (MATH 333 and MATH 475)] (3-0-3)

MATH 483

Design & Analysis of Experiments

Review of elementary probability and statistics; analysis of variance for design of experiments; estimation of parameters; confidence intervals for various linear combinations of the parameters; selection of sample sizes; various plots of residuals; block designs; Latin squares; one, two, and $2\hat{k}$ factorial designs; nested and cross factor designs; regression; nonparametric techniques.

Prerequisite(s): [(MATH 476)] (3-0-3)

MATH 484

Regression & Forecasting

Simple linear regression; multiple linear regression; least squares estimates of parameters; hypothesis testing and confidence intervals in linear regression models; testing of models, data analysis, and appropriateness of models; linear time series models; moving average, autoregressive and/or ARIMA models; estimation, data analysis, and forecasting with time series models; forecasting errors and confidence intervals. Credit may not be granted for both MATH 484 and MATH 564.

Prerequisite(s): [(MATH 474) OR (MATH 476)] (3-0-3)

MATH 485

Introduction to Mathematical Finance

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 will be explained and illustrated. Credit may not be granted for MATH 485 and MATH 548.

Prerequisite(s): [(MATH 475)] (3-0-3)

MATH 486

Mathematical Modeling I

The course provides a systematic approach to modeling and analysis of physical processes. For specific applications, relevant differential equations are derived from basic principles – for example, from conservation laws and constitutive equations. Dimensional analysis and scaling are introduced to prepare a model for analysis. Analytic solution techniques, such as integral transforms and similarity variable techniques, or approximate methods, such as asymptotic and perturbation methods, are presented and applied to the models. A broad range of applications from areas such as physics, engineering, biology, and chemistry are studied. Credit may not be granted for both MATH 486 and MATH 522.

Prerequisite(s): [(MATH 461)] (3-0-3)

MATH 487

Mathematical Modeling II

The formulation of mathematical models, solution of mathematical equations, interpretation of results. Selected topics from queuing theory and financial derivatives. Prerequisite(s): [(MATH 252)] (3-0-3)

MATH 488

Ordinary Differential Equations & Dynamical Systems

Boundary-value problems and Sturm-Liouville theory; linear system theory via eigenvalues and eigenvectors; Floquet theory; nonlinear systems: critical points, linearization, stability concepts, index theory, phase portrait analysis, limit cycles, and stable and unstable manifolds; bifurcation; and chaotic dynamics.

Prerequisite(s): [(MATH 251 and MATH 252)]

(3-0-3) MATH 489

VIAI II 409 Dartial Differential E

Partial Differential Equations First-order equations, characteristics.

second-order equations. Laplace's equation; potential theory. Green's function, maximum principles. The wave equation: characteristics, general solution. The heat equation: use of integral transforms.

Classification of

Prerequisite(s): [(MATH 461)] (3-0-3)

MATH 491 Reading & Research

Independent reading and research.

(Credit: Variable)

MATH 497

Special Problems Special problems. (Credit: Variable)

MATH 500

Applied Analysis I

Metric and Normed Spaces; Continuous Functions; Contraction Mapping Theorem; Topological Spaces; Banach Spaces; Hilbert Spaces; Eigenfunction Expansion. Prerequisite(s): [(MATH 400)]

(3-0-3)

MATH 501

Applied Analysis II

Bounded Linear Operators on a Hilbert Space; Spectrum of Bounded Linear Operators; Linear Differential Operators and Green's Functions; Distributions and the Fourier Transform; Measure Theory, Lebesgue Integral and Function Spaces; Differential Calculus and Variational Methods. Prerequisite(s): [(MATH 500)]

(3-0-3)

MATH 512

Partial Differential Equations

Basic model equations describing wave propagation, diffusion and potential functions; characteristics, Fourier transform, Green function, and eigenfunction expansions; elementary theory of partial differential equations; Sobolev spaces; linear elliptic equations; energy methods; semigroup methods; applications to partial differential equations from engineering and science.

Prerequisite(s): [(MATH 461) OR (MATH 489)] (3-0-3)

MATH 515

Ordinary Differential Equations & Dynamical Systems

Basic theory of systems of ordinary differential equations; equilibrium solutions, linearization and stability; phase portraits analysis; stable unstable and center manifolds; periodic orbits, homoclinic and heteroclinic orbits; bifurcations and chaos; nonautonomous dynamics; and numerical simulation of nonlinear dynamics.

Prerequisite(s): [(MATH 252)] (3-0-3)

MATH 519

Complex Anyalysis

Analytic functions, contour integration, singularities, series, conformal mapping, analytic continuation, multivalued functions.

Prerequisite(s): [(MATH 402)] (3-0-3)

MATH 522

Mathematical Modeling

The course provides a systematic approach to modeling and analysis of physical processes. For specific applications, relevant differential equations are derived from basic principles – for example, from conservation laws and constitutive equations. Dimensional analysis and scaling are introduced to prepare a model for analysis. Analytic solution techniques, such as integral transforms and similarity variable techniques, or approximate methods, such as asymptotic and perturbation methods, are presented and applied to the models. A broad range of applications from areas such as physics, engineering, biology, and chemistry are studied. Credit may not be granted for both MATH 486 and MATH 522.

Prerequisite(s): [(MATH 461)] (3-0-3)

MATH 525

Statistical Models & 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. (3-0-3)

MATH 530

Algebra

Axiomatic treatment of groups, rings and fields, ideals and homomorphisms; field extensions, modules over rings. Prerequisite(s): [(MATH 332) OR (MATH 430)] (3-0-3)

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)] (3-0-3)

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)] (3-0-3)

MATH 540

Probability

Random events and variables, probability distributions, sequences of random variables, limit theorems, conditional expectations, and martingales. Prerequisite(s): [(MATH 400)] AND [(MATH 475)] (3-0-3)

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. Credit may not be granted for Math 481 and Math 542.

Prerequisite(s): [(MATH 332) OR (MATH 333)] (3-0-3)

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 475)] (3-0-3)

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 474) OR (MATH 475) OR (MATH 543)]

(3-0-3)

MATH 545

Stochastic Partial Differential Equations

This course introduces various methods for understanding solutions and dynamical behaviors of stochastic partial differential equations arising from mathematical modeling in science, engineering, and other areas. It is designed for graduate students who would like to use stochastic methods in their research or to learn such methods for long term career development. Topics include the following: Random variables; Brownian motion and stochastic calculus in Hilbert spaces; Stochastic heat equation; Stochastic wave equation; Analytical and approximation techniques; Stochastic numerical simulations via Matlab; and applications to science, engineering, and other areas.

Prerequisite(s): [(MATH 540) OR (MATH 543) OR (MATH 544)] (3-0-3)

MATH 546

Introduction to Time Series

Properties of stationary, random processes; standard discrete parameter models, autoregressive, moving average, harmonic; standard continuous parameter models. Spectral analysis of stationary processes, relationship between the spectral density function and the autocorrelation function; spectral representation of some stationary processes; linear transformations and filters. Introduction to estimation in the time and frequency domains.

Prerequisite(s): [(ECE 511) OR (MATH 475)] (3-0-3)

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. Credit may not be granted for Math 485 and Math 548. Prerequisite(s): [(MATH 474) OR (MATH 475)] (3-0-3)

MATH 550

Topology

Topological spaces, continuous mappings and homeomorphisms, metric spaces and metrizability, connectedness and compactness, homotopy theory. Prerequisite(s): [(MATH 556)]

(3-0-3)

MATH 553

Discrete Applied Mathematics I

Graph theory is the study of systems of points with some of the pairs of points joined by lines. Sample topics include: paths, cycles, and trees; adjacency and connectivity; directed graphs; Hamiltonian and Eulerian graphs and digraphs; intersection graphs. Applications to the sciences (computer, life, physical, social) and engineering will be introduced throughout the course. This course runs concurrently with Math 454 but projects and homework are at the graduate level. Credit will not be granted for both Math 454 and Math 553.

Prerequisite(s): [(MATH 453)] (3-0-3)

MATH 554

Discrete Applied Mathematics II

Graduate level treatment of applied combinatorics; posets: product and dimension, lattices, extremal set theory and symmetric chain decomposition; combinatorial designs: block designs, Latin Squares, finite fields, block designs and Steiner systems, finite projective planes; coding theory: error-correcting codes, Hamming and sphere bounds, linear codes, codes from liar games and adaptive coding.

 $\label{eq:matrix} \begin{array}{l} \mbox{Prerequisite(s): [(MATH 453) OR (MATH 454) OR (MATH 553)]} \end{array}$

(3-0-3)

MATH 555

Tensor Analysis

Development of the calculus of tensors with applications to differential geometry and the formulation of the fundamental equations in various fields.

Prerequisite(s): [(MATH 332 and MATH 400)] (3-0-3)

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)] (3-0-3)

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. (3-0-3)

MATH 563

Mathematical Statistics

Theory of sampling distributions; interval and point estimation, sufficient statistics, order statistics, hypothesis testing, correlation and linear regression; analysis of variance; non-parametric methods. Credit given only for one of MATH 425, MATH 476, MATH 525, or MATH 563.

Prerequisite(s): [(MATH 475) OR (MATH 540)] (3-0-3)

MATH 564

Applied Statistics

Simple linear regression; multiple linear regression; least squares estimates of parameters; hypothesis testing and confidence intervals in linear regression models; testing of models, data analysis, and appropriateness of models; linear time series models; moving average, autoregressive and/or ARIMA models; estimation, data analysis, and forecasting with time series models; forecasting errors and confidence intervals. Credit may not be granted for both MATH 484 and MATH 564.

(3-0-3)

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)] (3-0-3)

MATH 566

Multivariate Analysis

Random vectors, sample geometry and random sampling, generalized variance, multivariate normal and Wishart distributions, estimation of mean vector, confidence region, Hotelling's T-square, covariance, principal components, factor analysis, discrimination, clustering.

 $Prerequisite(s): \ [(MATH 532, MATH 563, and MATH 564)] \ (3-0-3)$

MATH 567

Advanced Design of Experiments

Various type of designs for laboratory and computer experiments, including fractional factorial designs, optimal designs and space filling designs.

Prerequisite(s): [(MATH 474) OR (MATH 476)] (3-0-3)

MATH 568

Topics in Statistics

Categorical data analysis, contingency tables, log-linear models, nonparametric methods, sampling techniques. Prerequisite(s): [(MATH 563)] (3-0-3)

MATH 569

Statistical Learning

The wealth of observational and experimental data available provides great opportunities for us to learn more about our world. This course teaches modern statistical methods for learning from data, such as regression, classification, kernel methods, and support vector machines.

Prerequisite(s): [(MATH 350)] AND [(MATH 474) OR (MATH 475)]

(3-0-3)

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)]

(3-0-3)

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)]

(3-0-3)

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)]

(3-0-3)

MATH 581

Finite Element Method

Various elements, error estimates, discontinuous Galerkin methods, methods for solving system of linear equations including multigrid. Applications. Prerequisite(s): [(MATH 400)]

(3-0-3)

MATH 582

Mathematical Finance II

This course is a continuation of Math 485/548. It introduces the student to modern continuous time mathematical finance. The major objective of the course is to present main mathematical methodologies and models underlying the area of financial engineering, and, in particular, those that provide a formal analytical basis for valuation and hedging of financial securities.

Prerequisite(s): [(MATH 481) OR (MATH 542)] AND [(MATH 485) OR (MATH 548)] (3-0-3)

MATH 586

Theory & Practice of Fixed Income Modeling

The course covers basics of the modern interest rate modeling and fixed income asset pricing. The main goal is to develop a practical understanding of the core methods and approaches used in practice to model interest rates and to price and hedge interest rate contingent securities. The emphasis of the course is practical rather than purely theoretical. A fundamental objective of the course is to enable the students to gain a hand-on familiarity with and understanding of the modern approaches used in practice to model interest rate markets.

Prerequisite(s): [(MATH 485 and MATH 582*) OR (MATH 543 and MATH 582*)] An asterisk (*) designates a course which may be taken concurrently.

(3-0-3)

MATH 587

Theory & Practice of Modeling Risk & 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)] (3-0-3)

MATH 589

Numerical Methods for Partial Differential Equations

This course introduces numerical methods, especially the finite difference method for solving different types of partial differential equations. The main numerical issues such as convergence and stability will be discussed. It also includes introduction to the finite volume method, finite element method and spectral method. Prerequisite: An undergraduate numerical course such as MATH 350 and MATH 489 or consent of instructor.

Prerequisite(s): [(MATH 350 and MATH 489)] (3-0-3)

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. (3-0-3)

MATH 591

Research & Thesis M.S.

Prerequisite: Instructor permission required. (Credit: Variable)

MATH 593

Seminar in Applied Mathematics

Current research topics presented in the department colloquia and seminars. (1-0-0)

MATH 594

Special Projects

Special projects. (Credit: Variable)

MATH 595

Geometry for Teachers

The course is focused on fundamental ideas and methods related to Euclidean and Non-Euclidean (e.g., spherical) geometries in two and three dimensions and their applications with emphasis on the use of technology (e.g., Geometer's Sketchpad or Cabri dynamic geometry software) and relevance to geometric concepts in the pre-college mathematics curriculum context. Various problem-solving approaches and strategies will be emphasized based on posing hypotheses, their experimental testing and investigation, the use of formal axiomatic systems to construct and analyze proofs of the corresponding geometric theorems, and visual interpretations of the results. Participants will also complete an independent study module on some aspect of Non-Euclidean geometry not addressed in the course (e.g., read and report on the book, Flatland). The course is designed as a mathematics course for graduate students in the mathematics education and certification option programs, and for practicing secondary mathematics teachers. Prerequisite: 18 semester hours of an undergraduate mathematics major completed, certification as a mathematics teacher or approval of the instructor. (3-0-3)

MATH 596

Math for Teachers: Elementary

An in-service workshop for pre-college teachers emphasizing the phenomenological approach to the teaching of mathematics. Prerequisite: Certification as mathematics teacher or approval of the instructor. (Credit: Variable)

MATH 597

Reading & Special Projects

Special projects. (Credit: Variable)

MATH 598

Math for Teachers: High School

An in-service workshop for pre-college teachers emphasizing the phenomenological approach to teaching of integrated mathematics and science at the high school level. Prerequisite: Certification as mathametics teacher or approval of the instructor.

(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. (1-0-0)

MATH 601

Advanced Topics in Combinatorics

Course content is variable and reflects current research in combinatorics. Prerequisite(s): [(MATH 554)] (3-0-3)

MATH 602

Advanced Topics in Graph Theory

Course content is variable and reflects current research in graph theory. Prerequisite(s): [(MATH 554)] (3-0-3)

MATH 603

Advanced Topics in Computational Mathematics

Course content is variable and reflects current research in computational mathematics. Prerequisite(s): [(MATH 578)] (3-0-3)

MATH 604

Advanced Topics in Applied Analysis Course content is variable and reflects current research in applied analysis. Prerequisite(s): [(MATH 501)]

(3-0-3)

MATH 605

Advanced Topics in Stochastics

Course content is variable and reflects current research in stochastic. Prerequisite(s): [(MATH 544)] (3-0-3)

MATH 691

Research & Thesis Ph.D.

Research and thesis writing. (Credit: Variable)

School of Applied Technology

Daniel F. and Ada L. Rice Campus Illinois Institute of Technology 201 E. Loop Road Wheaton, IL 60187 630.682.6000 www.iit.edu/applied_tech/

Dean and Academic Director, Information Technology and Management Programs: C. Robert Carlson

Director of Operations: Maria Kozi-O'Donnell

Director, Professional Learning Programs: Carl Vizza

Director, Industrial Technology and Management Programs: Mazin Safar

Director, Marketing & Development: Scott Pfeiffer

Director, Information Technology: Ray Trygstad

Director, IIT Online: Lauren Wood

Degrees Offered

Master of Information Technology and Management Master of Cyber Forensics and Security Master of Industrial Technology and Operations

Master of Information Technology and Management

This 30-credit-hour course-only master's degree program is designed for working professionals who have a four year degree from an accredited college or university. Students

Master of Cyber Forensics and Security

This 30-credit hour course-only master's degree program is designed for experienced infomation technology professionals who have a four year degree from an accredited college or university. Students can find more informa-

Master of Industrial Technology and Operations

This is a 30 credit-hour, course-only master's degree program designed for those who plan to make a career in industry and have a four-year degree from an accredited college or university. For more information and

The School of Applied Technology (SAT) draws on IIT's extensive experience in adult education to offer technology-oriented training and education for working professionals. Courses are taught by IIT professors and industry professionals with significant working, teaching, and research experience in their fields. The IIT School of Applied Technology offers education and training in a wide variety of formats including degree, non-degree, certificate, credit, and non-credit programs; corporate training; short courses; and seminars ranging from a few hours to several days in length. Completion of any of IIT School of Applied Technology's non-credit courses will result in the assignment of Continuing Education Units (CEU) fully accredited by the International Association for Continuing Education and Training (IACET). Through IIT Online, the IIT School of Applied Technology markets and manages online delivery of IIT degree and non-degree educational offerings in all disciplines.

The IIT School of Applied Technology is based at the Daniel F. and Ada L. Rice Campus in Wheaton, Illinois, but also has a substantial presence at IIT's Main Campus in Chicago. The Industrial Technology and Management degree programs and IIT Online are located at the Main Campus, and both the Information Technology and Management degree programs and the Professional Learning Programs also operate extensively on the Main Campus.

can find more information and program description in the Information Technology and Management section of this bulletin or visit www.iit.edu/applied_tech/.

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program description, please consult the Industrial Technology and Management section of this bulletin or visit www.iit.edu/applied_tech/.
Academic Certificate Programs Offered

Advanced Software Development Certificate Cyber Security Management Certificate Cyber Security Technologies Certificate Data Center Operations and Management Certificate Data Management and Analytics Certificate Digital Voice & Data Communication Technologies Certificate

Professional Learning Programs Offered

Information Technology Certificate Programs Manufacturing/Industrial Technology Certificate Programs

Professional Learning Programs

Professional Learning Programs offer hands-on training classes designed for professionals who are either looking to upgrade their existing skills or make a career change into another field. All classes are held in state-of-theart classrooms and computer labs and are taught by IIT faculty members or by industry professionals who enhance the learning process with real-world knowledge and experience.

Particular areas of focus include information technology, manufacturing and industrial technology and management, and engineering, but all other disciplines within the university are represented as well. Courses are available as ten to seventeen week certificate programs, as corporate training, and as short courses and seminars ranging from a few hours to several days in length. Instructor-mediated online courses are also available.

IIT Online

Online learning at IIT allows students to view course lectures and download course materials from the Internet from anywhere on earth. While each academic department and program determines the availability of online courses and degrees, it is the role of IIT Online to market and manage the online delivery of IIT degree and non-degree educational offerings across all university disciplines. IIT Online has developed a set of internet and online solutions and services to accommodate different instructional and managerial needs. These solutions range from rapid delivery with live recording of traditional classroom courses and immediate release to the Information Technology Innovation, Leadership and Entrepreneurship Certificate Systems Analysis Certificate System Administration Certificate Web Design and Application Development Certificate

Professional Engineer (EI) Engineering Intern (EI) Review

Short Course (one to five days) in all disciplines

All courses are designed to meet professional continuing education requirements and carry Continuing Education Unit (CEU) credit.

Professional Learning Programs offer many programs for international students, profesionals, universities, English teachers, and corporations. Programs of various lengths are aimed at increasing participants' listening and speaking skills in English. The short-term programs focus on increasing participants' English and professional skills, while the semester programs focus on increasing English skill while also developing students' technical and business skills.

Detailed information regarding the course offerings of IIT's Professional Learning Programs is available at www.iit.edu/applied_tech or by calling 630.682.6035.

online classroom, to formal studio productions accompanied by a full cycle of Instructional Design development. Whether delivering just-in-time or fully customized solutions, IIT Online is committed to quality remote learning and making innovative use of technology to enhance learning outcomes. Placing the learner at the center of the educational practice, IIT Online has developed a methodology for making the best use of technology and promoting quality interactive educational experiences for students all over the world. For more information on IIT Online and their role in an IIT education please see http://iit.edu/iit_online/.

College of Architecture

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Wiel Arets	Peter L. Osler	
Associate Dean for Graduate Academic Affairs: Catherine Wetzel	Director of Master of Integrated Building Delivery Program: Thomas Brock	
Associate Dean for Undergraduate Academic Affairs: Robert Krawczyk	Director for Buildings and Operations: Richard Nelson	
Assistant Dean for Undergraduate Academic Affairs:	Director of Graduate Admissions: John DeSalvo	
R. Stephen Sennott Director for Graduate Academic Affairs: TBD	Manager of Academic Affairs and Communication: Sarah Pariseau	

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 IIT offers unique combinations, intertwining design and technology to produce advanced architecture. Our commitment includes the

Accreditation

In the United States, most state registration boards require a degree from an accredited professional degree program as a prerequisite for licensure. The National Architectural Accrediting Board (NAAB), which is the sole agency authorized to accredit U.S. professional degree programs in architecture, recognizes three types of degrees: the Bachelor of Architecture, the Master of Architecture, and the Doctor of Architecture. A program may be granted a 6-year, 3-year, or 2-year term of accreditation, depending on the extent of its conformance with established educational standards.

Master's degree programs may consist of a preprofessional undergraduate degree and a professional graduate degree that, when earned sequentially, constitute an accredited professional education. However, the preprofessional degree is not, by itself, recognized as an accredited degree. 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.

The College of Architecture has two NAAB accredited degrees: the Bachelor of Architecture and the Master of Architecture Professional Degree Programs. Both hold 6-year terms of accreditation with the NAAB.

The Master of Landscape Architecture (M.L.A.) degree program is accredited by the Landscape Architectural Accreditation Board (LAAB). The program was granted accreditation for a six-year period for the course of study leading to the first professional M.L.A. degree in 2010.

The 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.

Degrees Offered

Master of Architecture (M. Arch.), Professional Degree Master of Landscape Architecture (M.L.A.), Professional Degree Master of Science in Architecture (M.S.Arch.), Post-Professional Degree

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 IIT campus facilities, students have some of the finest instructional spaces in the United States.

A branch of the Paul V. Galvin Library, 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; maintaining additional resources, including the Crown Hall darkroom, the CoA Archives, the Graham Resource Center Web Page, and an Audio-Visual equipment collection; providing reference and research assistance to local, national, and international clients about architecture in general and IIT and Mies van der Rohe in particular; and providing bibliographic instruction to all GRC and Architecture researchers and users.

Master of Integrated Building Delivery (M.I.B.D.), Post-Professional Degree Dual Master of Architecture/Master of Integrated Building Delivery Doctor of Philosophy in Architecture (Ph.D.)

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 and a Precix Series 9100 CNC Router for digital fabrication.

The College houses two computer labs, with a third instruction lab in Siegel Hall, with over 70 PCs outfitted with the latest Architectural Digital Design and Fabrication software. All Labs and requisite software are listed here: http://www.iit.edu/ots/computer_labs.shtml. The Lab PCs are updated every third year to support curriculum initiatives and technology advances, such as BIM (Building Information Modeling), and serve as digital imaging and rendering instruction spaces for the College. When not in use for class, the Labs are open to students and offer 24 hr 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 university campus is a wireless zone serving the IIT 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 the construction of significant buildings at all scales. 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 and new urban cultures; the influence of climate and environment upon building form, sustainable design and energy efficiency; biophilic design; advanced critical analysis and 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, lowdensity, and affordable housing.

Faculty

Arets, Wiel, John H. and Jeanne M. Rowe Professor of Architecture and Incoming Dean of the College of Architecture. M.Arch., Technical University of Eindhoven (Netherlands).

Brock, Thomas, Studio Associate Professor and Director of the Master of Integrated Building Delivery Program. B.Arch. University of Cincinnati; M. Arch., University of Pennsylvania. Architectural design, construction technologies, and digital media.

Brown, Marshall, Assistant Professor. B.A. Washington University-St. Louis; M.Arch., M.A.U.D., Harvard University. Architectural design and theory, urbanism.

Brown, Timothy, Studio Associate Professor and Director of the College of Architecture International Affairs. B.S.Arch., Clemson University; M.Arch., University of Illinois-Chicago. Architectural design and theory.

Conger-Austin, Susan, Studio Associate Professor and Masters Projects Director. B.A., Stanford University; M.Arch., Princeton University. Architectural design and theory.

Denison, Dirk S., Professor. B.Arch., M.B.A., Illinois Institute of Technology; M.Arch., Harvard University. Architectural design, community design, and community planning.

DeSalvo, John, Studio Associate Professor and Director of Graduate Admission. B.S., University of Illinois, Urbana-Chamgaign; B.Arch, M.Arch., Cornell University. Architecture design and freehand rendering, energy saving design, and detailing.

Elnimeiri, Mahjoub, Professor and Director of the College of Architecture Doctorate Program. B.S., University of Khartoum (Sudan); M.S., University of London, Imperial College (England); Ph.D., Northwestern University. Structural engineering and sustainability.

Endres, Paul, Studio Associate Professor. B.S., University of Illinois, Urbana-Chamgaign; M.A., M.S., University of California-Berkeley. Structural engineering, structural integration.

Felsen, Martin, Studio Associate Professor. B.Arch., Virginia Polytechnic Institute; M.S., Columbia University. Architectural design, urban design, and digital technolgies.

Flury, Frank, Associate Professor. M.Arch., Diploma, University of Karlsruhe (Germany). Architectural design, design/build.

Humer, Colleen M., Studio Assistant Professor. B.F.A., B.Arch., University of British Columbia (Canada); M.A., University of Toronto (Canada). Architectural design, architectural history and theory. Johnson, Leslie M., Studio Assistant Professor. B.Arch., Illinois Institute of Technology; M.Arch., Bartlett School of the Built Environment, University College London (England). Architectural design and theory, dwellings.

Kearns, Thomas, Studio Associate Professor. B.Arch., Iowa State University. Architectural design and theory, digital technologies.

Keller, Sean, Assistant Professor. B.A., M.Arch., Princeton University; Ph.D. Harvard University. History and theory of architecture.

Kibler, Steve, Studio Associate Professor. B.S., M.Arch., University of Illinois, Urbana-Champaign. Steel structures, concrete structures, and design/build.

Krawczyk, Robert, Professor and Associate Dean of Undergraduate Academic Affairs. B.Arch., University of Illinois-Chicago. Computer-aided design and advanced digital applications.

Krueck, Ronald, Studio Professor. B.Arch., Illinois Institute of Technology. Architectural design and theory.

Kultermann, Eva, Associate Professor. B.Arch., University of Arkansas; M.S., Oxford Brooks University. Design and theory, design build, sustainability.

Land, Peter, Professor of City and Regional Planning. A.A. Dipl., M. Arch., Carnegie Institute of Technology; M.C.P., Yale University. Innovative structures, building technologies and materials, low-energy design; highdensity, low-rise housing; urbanism and planning.

Mallgrave, Harry Francis, Professor. B.E.S., M.Arch., University of Detroit; Ph.D., University of Pennsylvania. History and theory of architecture.

Mattson, Mary Pat, Studio Assistant Professor. B.A., College of William and Mary; M.L.A., University of Virginia. Landscape architectural design and practice, ecological and landscape urbanism.

Miller, Jonathan, Studio Associate Professor. B.A., Yale University; M.F.A., New York University. Architectural design and theory; film studies.

Nagle, Kathleen, Studio Associate Professor. B.A., Williams College; M.Arch., Harvard University. Architectural design, introduction to architecture.

Nelson, Richard, Studio Associate Professor and Director of Buildings and Operations. B.A., M. Arch., Washington University-St. Louis. Architectural design and building technology.

Osler, Peter L., Assistant Professor and Director of M.L.A. Program. B.S., University of Michigan; M.L.A., M. Arch., Harvard University. Landscape architecture.

Peluso, Alphonso, Studio Associate Professor and Director of Digital Curriculum. B.Arch., Illinois Institute of Technology. Digital design. Pettigrew, Paul, Studio Associate Professor. B.S., University of Illinois, Urbana-Champaign; M.Arch., Massachusetts Institute of Technology. Architectural design, furniture design/build, introduction to architecture.

Riley, Benjamin R., Studio Associate Professor. B. Arch., Illinois Institute of Technology. Architectural design, visual training.

Robertson, Donna V., John H. and Jeanne M. Rowe Professor. B.A., Stanford University; M.Arch., University of Virginia. Architectural design and practice, preservation, case study methodology.

Rockey, Christopher, Assistant Professor. B.S., M.Arch., University of Illinois. Structural engineering, constructability, efficiency.

Ronan, John, Professor. B.S., University of Michigan; M.Arch., Harvard University Graduate School of Design. Architectural design and material investigation.

Schachman, Andrew, Studio Associate Professor and Director of the Paris Program. B.A., University of Chicago; M.Arch., University of Illinois-Chicago. Architectural design. Schipporeit, George, Associate Professor. Architectural design and sustainable cities.

Takeuchi, Arthur, Associate Professor. B.Arch., M.S.Arch., Illinois Institute of Technology. Architectural design.

Tinucci, Andrew, Studio Assistant Professor. B.Arch., University of Arizona; B.S., University of Illinois, Urbana-Champaign. Architectural design and theory, urbanism.

Wetzel, Catherine, Associate Professor and Associate Dean for Graduate Academic Affairs. B.Arch., University of Cincinnati; M.Arch., University of Pennsylvania. Architectural design and visual training.

Wood, Antony, Studio Associate Professor. B.A., Diploma in Architecture, PGCHE. University of Nottingham; PG.Dip.Arch.Prac., De Montford University-Leicester. Architectural design and sustainability.

Admission Requirements

Completed application form Cumulative Undergraduate GPA: minimum 3.0/4.0 Portfolio Three letters of recommendation Statement of intent Official transcripts GRE score minimum: 292 combined, 2.5 analytical writing TOEFL minimum: 80/550 (internet/paper-based test scores) Application Fee of \$55 All programs require a minimum undergraduate grade point average of 3.0 on a 4.0 scale.

Applicants must submit a portfolio of previous academic or professional work in a portable and professionally acceptable format (8.5 by 11 inches or smaller), three 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 IIT, and GRE scores, which are less than five years old.

International applicants from non-English speaking countries are required to submit TOEFL scores of 550/80

(paper-based test score scale/internet-based) or above. Admitted international students with TOEFL scores between 550/80 and 600/100 will be required to take an English proficiency exam upon arrival at IIT; 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 entire term 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.

Master of Architecture - Professional Degree

The Master of Architecture first professional degree serves those students seeking a consummate professional education. The degree is accredited by the National Architectural Accreditation Board (NAAB), and is a necessary component for licensure in the field.

The IIT College of Architecture's graduate professional Architecture degree program emphasized the integration of architectural design, theory, and technology. Through rigorous work and critical thought, the college promotes innovation and underscores refinement with the obejctive 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 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.

The program culminates in an independent Master's Project, which demonstrates excellence in design with a final product that is environmentally conscious, socially responsible, and technologically advanced. The Master's Projects are grouped into areas of focus that include but are not limited to: sustainable cities, building delivery practices, community based planning, history and theory, advanced technologies, housing and urban design, high rise typology, and cultural institutions.

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 from the U.S) or international student 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 acceptance of Advanced Standing. International students with a Bachelor of Architecture degree (or equivalent) who wish to pursue a 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 bachelors 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 a minimum of 60 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. The total number of credit hours, which will be required for graduation, will be established by each student's individual program of study.

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 college level physics course equivalent to IIT's PHYS 212;
- 2. An understanding of basic mathematical principles and analytical procedures, including algebra, geometry, and trigonometry, as demonstrated through the successful completion of college-level mathematics equivalent to IIT's MATH 122;
- 3. A basic ability to produce freehand drawings of architectural forms and spaces, as demonstrated by the successful completion of one college-level drawing course or by portfolio submissions;
- 4. A basic understanding of design, as demonstrated by the successful completion of one college-level design course or by portfolio submissions; 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.

M.Arch. Curriculum

1st Year Fall		Credits
ARCH 500	History of Architectural Ideas I	3
ARCH 505	Ecology, Sustainability, and Site	3
ARCH 506	Visual Training Digital Media	3
ARCH 541	Methodology, Material, Technique	6
Total Hours		15

2nd Year		
Fall		Credits
ARCH 403	Building Systems I	3
ARCH	Visual Training Elective	3
ARCH 486	Structural Engineering	3
ARCH 502	Adv. Topics in History and Theory Elective I	3
ARCH 543	Structurally Determinant Project	6
Total Hours		18

1st Year		
Spring		Credits
ARCH 485	Intuitive Structures	3
ARCH 501	History of Architectural Ideas II	3
ARCH 507	Visual Training Material Exploration	3
ARCH 508	Digital Applications in Design	3
ARCH 542	Materiality Projects	6
Total Hours		18

2nd Year		
Spring		Credits
ARCH 404	Building Systems II	3
ARCH 503	Adv. Topics in History and Theory Elective II	3
ARCH 509	Topics in Advanced Technology	3
ARCH 565	Project Mgmt. and Construction Administration	3
ARCH 544	Comprehensive Building Project Elective	6
Total Hours		18

3rd Year		
Fall		Credits
ARCH 520	Principles of Urban Planning and Design	3
ARCH 523	Master's Project Preparation	3
ARCH 545	Community Based Building Project	6
	Elective	
ARCH	Professional Practice Elective	3
561/62/63		
Elective	Architecture Related	3
Total Hours		18

3rd Year		
Spring		Credits
ARCH 560	Integrated Building Delivery Practice	3
ARCH 593	Master's Project	6
Elective	Architecture Related	3
Elective	Architecture Related	3
Total Hours		15

102

There are a wide variety of electives available not only in the College of Architecture, but also in IIT's Armour College, Institute of Design, and the 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 postprofessional Master of Science in Architecture program may petition for dual enrollment.

Master of Science in Architecture

The one-year program, two or three semesters in duration, typically lasts a full calendar year. The program is open to applicants holding accredited Bachelor of Architecture (B.Arch.) degrees as first professional degrees from NAAB-accredited institutions or equivalent professional architecture degrees from international institutions. The Master of Science in Architecture program offers advanced architectural study that builds upon knowledge acquired from the Bachelor of Architecture degree; it combines courses and in-depth research concerning a specific area of concentration. The program pursues a high level of architectural research, analysis and synthesis through thesis work in design, structures, systems, digital media and other topics. Areas of faculty excellence in the thesis program include:

Specialization in Sustainable New Cities

Candidates interested in the area of Sustainable New Cities may pursue a formal specialization within the Master of Science in Architecture program. Focusing upon the critical issue of global sustainability, this specialization strives to address the urban challenges of acceler-

Admission and Curriculum Requirements

Candidates for the post-professional Master of Science in Architecture must hold an accredited Bachelor of Architecture (B.Arch) or Master of Architecture (M.Arch) as a professional degree from an NAAB accredited institution if earned within the U.S. International applicants must hold a Bachelor of Architecture or Master of Architecture degre or equivalent and be eligible for licensure in their home country.

In addition to the standard requirements for graduate admission, a personal interview with the director of the degree program is highly recommended. The program of study includes a minimum of 32 credit hours, of which at least eight are in ARCH 591 (Research and Thesis). Students entering the post-professional degree program should develop a detailed outline of their thesis project

- (a) High-rise and long-span design;
- (b) Environmentally conscious design;
- (c) Advanced information systems;
- (d) Innovative design methodologies and architecture;
- (e) Advanced programming issues in housing, and other topics;
- (f) Critical and theoretical assessments pertaining to construction and the built environment; and
- (g) Advanced critical analysis and history/theory.

ating global demand for energy and the design of completely new sustainable cities. Elective courses are selected from a variety of interdepartmental course offerings related to the area of Sustainable New Cities.

for approval by the director of thesis programs and their thesis advisor. The program of study for each student is developed individually with the thesis advisor. Study begins with investigation and analysis for the thesis under the direction of the advisor. By the second semester, a thesis committee of three faculty members oversees the work being produced. Students are required to take advanced courses related to their specialized areas of interest.

The final semester of study concludes the entire thesis project in writing, analysis, programming, and design. Thesis studies should offer the graduate a higher level of professionalism, significantly evolving one's career and the ability to make special contributions to the field.

Master of Science in Architecture Curriculum

Fall		Credits
ARCH 588	Thesis Preparation Seminar	3
ARCH 590	Research and Analysis	6
Elective	Architecture Related	3
Elective	Architecture Related	3
Total Hours		15

Spring		Credits
ARCH 591	Research and Thesis	6
Elective	Architecture Related	3
Elective	Architecture Related	3
Elective	Architecture Related	3
Total Hours		15

Summer/Fall		Credits
ARCH 591	Research and Thesis	2
Total Hours		2

Total Credit Hours

 $\mathbf{32}$

Master of Integrated Building Delivery – Post-Professional Degree

The Master of Integrated Building Delivery program focuses upon providing comprehensive delivery strategies to promote a quality built environment. The program will educate architects to more actively participate in, guide, and/or undertake the full range of entrepreneurial and innovative activities comprising design, develop and build initiatives. Architecture has generally involved the conceptual basis of project initiation as well as the documentation and management of implementing methodology. Some architects, in response to the broad definition of the profession, must have the abilities and leadership skills to empower the individual toward a position of competency and responsibility in the broader and complex processes of design and construction. The Master of Integrated Building Delivery program aims to provide this knowledge and skill set to those who have already assimilated, or are in the process of acquiring, the more traditional scope of an architectural education. The program is interdisciplinary by design and each course will be taught by an expert in the particular field of study. It is therefore encouraged that electives be pursued from allied colleges within the University including Stuart School of Business, Chicago-Kent College of Law, and Armour College of Engineering. The Master of Integrated Building Delivery is a post-professional degree program and may be completed in as few as two semesters.

Admission and Curriculum Requirements

Candidates for the post-professional degree program must hold an accredited Bachelor of Architecure (B.Arch) or Master of Architecture (M.Arch) as a professional degree from an NAAB accredited institution if earned within the U.S. International aplicants must hold a professional Bachelor of Architecture or Master of Architecture degree or equivalent and be eligible for licensure in their home country.

The Master of Integrated Building Delivery program of study requires a minimum of 30 credit hours. The program is course based with the opportunity for independent investigation in the Comprehensive Development Project and the Project Sector Studies. In order to allow working professionals to attend, courses will be scheduled for evening and weekend hours. The Comprehensive Development Project or Practicum provides two options for the acquisition and assimilation of the breadth of knowledge required to bring projects 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 entails employment at a vetted office, engaged in the actual process of project assembly.

M.IBD Curriculum

Fall		Credits
ARCH 560	Integrated Building Delivery	3
ARCH 561	Entrepreneurship and Innovation in Arch	3
ARCH 562	Planning Law & Land Development	
	Policies	
ARCH 563	Real Estate Financial Fundamentals	3
ARCH 566	Project Sector Studies/Case Studies	3
Total Hours		15

Total Credit Hours

30

Spring Credits ARCH 564 Comprehensive Development 6 Project/Practicum ARCH 565 Project Management & Construction 3 Contract Administration Elective Topic Related 3 Elective Topic Related 3 Total Hours 15

Dual Master of Architecture with Advanced Standing/Master of Integrated Building Delivery

The intent of the dual degree program is to respond to the interests of those students who recognize the intrigue of expanding their goals from designing the built environment, to effecting or otherwise participating in the realization of the built environment. The content and the intentions of the component curriculums remain intact and undiminished.

Architecture has generally involved the conceptual basis of project initiation as well as the documentation and

Admission and Curriculum Requirements

The dual M.Arch/M.IBD program requires a bachelor's degree in any discipline from an accredited university. In order to be admitted to the dual degree, applicants must complete all of the admission requirements for the M.Arch. program. In addition, a professional statement specifically addressing the interest in the Dual M.Arch./M.IBD. program is required.

Candidates may apply for the dual degree during their initial application. An application to the Dual M.Arch./M.IBD. degree does not guarantee admission to both programs. If an application is denied for the M.Arch. portion of the degree, candidates will not be eligible for the M.IBD. degree program unless they fulfill the post-professional degree requirements. Continuing students in the M.Arch. program may apply for the Dual M.Arch./M.IBD. program prior to their final semester in the M.Arch. program. management implementing methodology. Some architects, in turn, must have the abilities and the leadership skills to empower the profession toward a position of competency and responsibility in the broader and complex processes of design and construction. By integrating the NAAB accredited Master of Architecture (M.Arch.) and the Master of Integrated Building Delivery (M.IBD), the dual degree aims to provide this knowledge and skill set to those who wish to have the delivery option inform their studies throughout their architectural education.

Two required courses within the M.IBD. program are directly repeated within the M.Arch. program (ARCH 560 and ARCH 565). Another M.Arch. requirement, a Professional Practice Elective, is fulfilled by the student's choice of ARCH 561, ARCH 562, or ARCH 563 from the M.IBD. program. This overlap of 9 credit hours is applied to a reduction of required courses for the dual degree. Furthermore, the M.IBD. program requires two electives, in a related course of study. These two courses will also apply to the M.Arch. curriculum. A summation of requisite credit hours for each degree program would entail 102 credits for the M.Arch., and 30 for the M.IBD. With the credited overlay, the dual degree program would be awarded upon completion of 117 credit hours.

College of Architecture

Dual M.Arch./M.IBD. Curriculum

1st Year Fall		Credits
ARCH 500	History of Architectural Ideas I	3
ARCH 505	Ecology, Sustainability, and Site	3
ARCH 506	Visual Training Digital Media	3
ARCH 541	Methodology, Material, Technique	6
Total Hours		15

2nd Year Credits Fall ARCH 403 Building Systems I 3 ARCH Visual Training Elective 3 3 ARCH 486 Structural Engineering 1 - - - 1 ARCH 502 Adv. Topics in Hi Elective I ARCH 543 Structurally De Total Hours

0			
History and Theory	3	ARCH 509	Topics in Advanced Technology
		ARCH 565	Project Mgmt. and Construction
eterminant Project	6		Administration
-	18	ARCH 544	Comprehensive Building Project
			Elective
		Total Hours	
		3rd Year	
	Credits	Spring	
rban Planning and Desig	m 3	ARCH 564	Comprehensive Project/Practicu

1st Year

ARCH 501

ARCH 507

ARCH 508

ARCH 542

Total Hours

2nd Year

ARCH 404

ARCH 503

Spring

Intuitive Structures

Materiality Projects

Building Systems II

Elective II

History of Architectural Ideas II

Digital Applications in Design

Visual Training Material Exploration

Adv. Topics in History and Theory

Spring ARCH 485

Fall		Credits
$\overline{\text{ARCH 520}}$	Principles of Urban Planning and Design	3
ARCH 523	Master's Project Preparation	3
ARCH 545	Community Based Building Project	6
	Elective	
ARCH	Professional Practice Elective	3
561/62/63		
Elective	Dual Elective	3
Total Hours		18

4th Year		
Fall		Credits
ARCH 560	Integrated Building Delivery Practice	3
ARCH	Professional Practice Elective*	3
561/62/63		
ARCH	Professional Practice Elective*	3
561/62/63		
Elective	Dual Elective	3
Elective	Architecture Elective	3
Total Hours		15

3rd Year		
Spring		Credits
ARCH 564	Comprehensive Project/Practicum	6
ARCH 566	Project Sector Studies/Case Studies	3
ARCH 593	Master's Project	6
Total Hours		15

Credits

3

3

3

3

6

18

Credits

3

3

3

3

6

 $\mathbf{18}$

Total Credit Hours

3rd Year

117

*One of these courses will be used as a M.Arch.required ARCH 561/62/63 Professional Practice Elective, the other two will be required for the M.IBD. program.

Master of Landscape Architecture

More than ever, the world needs more informed, more innovative, more critically involved landscape architects. Globally, population growth, changing climate, and continued depletion of natural resources question historical planning and design models. Landscape architects have emerged among design professionals to lead in the reclamation, organization, and understanding of our cities to meet these 21st century challenges. Among American cities, Chicago presents unique opportunities to test and celebrate the potential of urban environments to transform these conditions of crisis to promise, neglect to value, banality to poetry. Lakes Basin, where twenty percent of the world's fresh water supply is both a vital natural resource and an economic catalyst for the mega-region. While Chicago enjoys the legacy of a world-class park system sponsored by the 1893 Columbian Exposition, the world-renowned Chicago Botanic Garden, and the Prairie School Landscape aesthetic, it is steadily being transformed by a set of contemporary interests. Millennium Park, Chicago Green Roof and Sustainability Initiatives, Green Streets, the Bloomingdale Trail, and the regeneration of the Chicago River, characterize the emergence of Chicagos 21st century landscape.

Chicago is geographically positioned within the Great

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, or 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 Curriculum

1st Year Fall		c	Credits
LA 501	Nature of Ecology		3
LA 525	Representing and Modeling the Landscape		3
LA 541	Studio I: Dynamics and Processes Places	of	6
LA 565	Ecology and Materials Workshop Plants and Planting	I:	3
Total Hours			15

1st Year Spring		Credits
LA 502	Landscape Architectural History: From Antiquity to Olmsted	3
LA 526	Digital Media	3
LA 542	Studio II: Site and City	6
LA 566	Ecology and Materials Workshop II: Earthworks and Infrastructures	3
Total Hours		15

2nd Year Fall Credits LA 515 Firms, Parks, Developers 3 LA 527 Advanced Modeling and Fabrication 3 LA 543 Studio III: Comprehensive Landscape $\mathbf{6}$ Design LA 567 Ecology and Materials Workshop III: 3 Horticulture and Design Total Hours $\mathbf{15}$

2nd Year Spring	,	Credits
LA 503	Advanced Contemporary Theory: Case	3
LA 514	Professional Practice in Landscape Architecture	3
LA 544	Studio IV: Site, City, and Region	6
LA 583	Ecology and Materials Workshop IV: Manufacturing the Urban Environment	3
Total Hours		15

3rd Year		
Fall		Credits
LA 516	Historic Landscape Preservation	3
LA 545	Studio V: Advanced Landscape Design Investigations	6
Elective	Related to Landscape Research	3
Elective	Related To Architecture	3
Total Hours		15

3rd Year		
Sping		Credits
LA 546	Studio VI: Advanced Landscape Design	6
	Investigations	
Elective	Landscape Architecture Elective	3
Elective	Related to Landscape Research	3
Elective	Related to Architecture	3
Total Hours		15

Total Credit Hours

90

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

Doctor of Philosophy in Architecture

The Doctor of Philosophy in Architecture (Ph.D.) program is for those advanced graduate students who plan to pursue careers in the academic and research fields and/or in the area of advanced professional practice within the domain of architecture. The rigor of study required for the Ph.D. degree extends the discipline of advanced research and design beyond the master degree and is oriented toward professional applications and academic scholarship.

The program requires a comprehensive knowledge of architecture, a deep understanding of its accomplishments

Admission Requirements

An applicant to the doctoral program must hold a professional Master of Architecture degree (M.Arch.) from an NAAB accredited U.S. university or the equivalent. Candidates who have not completed the required professional M.Arch. degree may apply for either the Master of Architecture or the Master of Science in Architecture program at IIT to fulfill that requirement, as a non-terminal program of studies preparatory for the doctoral program.

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, which will include a minimum of 26 credit hours of course-work. 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. and developments, and critical inquiry that extends its frontiers.

The program combines course-work and research, culminating in a Ph.D. dissertation of extensive and independent, original investigation which could also lead to a design development. The research in some cases may be an extension of work done in the preparation of a Master of Architecture degree in the College of Architecture. Each student's program of study will include seminars, specialized and elective course-work, research, and design as preparation for the dissertation.

The applicant should meet all entrance requirements of IIT's Graduate College, plus a minimum cumulative grade point average of 3.5 on a 4.0 scale; a TOEFL score of at least 80/550; and at least three letters of recommendation, from immediate supervising professors. The applicant should also submit a statement of purpose indicating a subject of study or research work and should provide a portfolio demonstrating the qualities of his or her accomplishments and expertise.

Upon completion of the first academic year, the candidate will be required to pass a Qualifying Examination before he or she will officially be admitted to Ph.D. candidacy. At the end of the program, the candidate will take a final examination which will consist of an oral presentation and defense of the dissertation. Current areas of study include high-rise and long-span buildings, technology applications, energy conscious design, emerging urbanisms, housing, history/theory, and advanced computer applications. Work for the Ph.D. must be completed within six years after admission to doctoral candidacy.

Course Descriptions

Architecture

ARCH 500

History of Architectural Ideas I

A comprehensive and critical reading of architectural ideas and built form from classical times until the late 19th century. With a focus on primary readings and building documentation, the course surveys the embodiment of ideas within the panorama of changing styles, techniques, and attitudes, highlighting the critical debates of each epoch. It places an emphasis on the great complexity of social, political, intellectual, and material forces affecting architectural thought and design. Critical reading and writing skills will be emphasized. Open only to Architecture majors.

(3-0-3)

ARCH 501

History of Architectural Ideas II

The second half of a two-semester survey, this course is devoted to the history of architectural ideas from 1900 to the present. It begins with the first attempts to formulate a modern architecture in the early years of the twentieth century; continues to address the consolidation of modern architecture between the world wars, postwar extensions of modernism, and the critiques posed by various forms of post-modernism; and concludes with a range of contemporary issues, including globalization, digital technology, and sustainability. With a focus on primary readings and building documentation, the course is intended to survey the embodiment of ideas within the panorama of changing styles, techniques, and attitudes. It places an emphasis on the great complexity of social, political, intellectual, and technological forces affecting design. Critical reading and writing skills will be emphasized. Open only to Architecture majors. (3-0-3)

ARCH 502

Advanced Topics in History & 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. Open only to Architecture majors. (3-0-3)

ARCH 503

Advanced Topics in History & 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. Open only to Architecture majors. (3-0-3)

ARCH 505

Ecology, Sustainability, & Site

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. Open only to Architecture majors. (3-0-3)

ARCH 506

Visual Training Digital Media

The development of visual acuity through the analysis of aesthetic expression. Exercises in visual perception and aesthetic judgment transition from traditionally hand manipulated to digital media. Critical inquiry of media; isolation and analysis; interdependence and integration of sensuous qualities. Exercises include the study of proportion and rhythm, texture and color, mass and space. Topics of inquiry vary. Open only to Architecture majors. (1-2-3)

ARCH 507

Visual Training Materials Exploration

The course will include the research and study of the architectural surface and the integration into built form. Facade systems, enclosure assemblies, and related materials will be investigated as part of a graphic study as well as full scale built application. The relationships of materials and construction methods will be evaluated with respect to architectural expression and performance. Open only to Architecture majors.

Prerequisite(s): [(ARCH 506)]

(1-2-3)

ARCH 508

Digital Applications in Design

An exploration of digital design applications and techniques as a means of architectural information expression. This class will look at the elaborate toolset of digital design in architectural practice with a primary focus on Building Information Modeling. Utilizing BIM and Parametric modeling, the students will generate 3D building models for use in design, energy analysis, estimating scheduling and renderings. BIM provides continuous immediate feedback for the student and, through utilizing this model, the student will also be aware of this new efficient way for multi-disciplines to work collaboratively. Open only to Architecture majors. Prerequisite(s): [(ARCH 506)]

(1-2-3)

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. Open only to Architecture majors. (3-0-3)

ARCH 520

Principles of Urban Planning & Design

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. Although the more disciplinary concerns of urban design will be covered in the concurrent Arch 545 studio, this course will also develop a context for understanding the role of design in shaping the urban environment. Open only to Architecture majors. Corequisite(s): (ARCH 545)

(3-0-3)

ARCH 523 Master's Project Preparation: Research Analysis & 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. Open only to Architecture majors. (3-0-3)

ARCH 541

Methodology, Material, & Technique

This studio is an introduction to design methods and fundamental architectural principles through exercises focusing on methodology, materiality, and architectural language. Exercises sequentially become more complex in relation to the physical properties and qualities of spatial complexity, function, and materiality. Emphasis on exploration and technique within the design process. Open only to Architecture majors.

(0-12-6)

ARCH 542

Materiality Projects

This studio explores the relationship between spatial definition and material properties, construction methods, and structural typologies through a series of sequential architectural projects. It introduces architecture as an integrated practice that unifies intention, material, construction, and spatial definitions. Emphasis is placed on materials and applications as fundamental components of architecture. The course promotes a collaborative approach as essential to research and professional practice. Open only to Architecture majors.

Prerequisite(s): [(ARCH 541)] (0-12-6)

ARCH 543

Structurally Determinant Project

This studio introduces the premise that design and the pursuit of architecture is enhanced by the integration of and sensitivity to the essential determinates of the composition. Sensitivity will be developed through a single architectural project and accompanying structural component that will focus on the way in which site, function, and material choice coalesce into a structurally determinant form. Open only to Architecture majors.

Prerequisite(s): [(ARCH 542)] (0-12-6)

ARCH 544

Comprehensive Building Project

This studio focuses on the design of a single building demonstrating the synthesis of ecological planning, programming, and code with zoning analysis, structure, and building systems. Students will be able to select from varied studio topics. Open only to Architecture majors. Prerequisite(s): [(ARCH 543)]

(0-12-6)

ARCH 545

Community-Based Building Project

In this studio, students will be introduced to the discipline and techniques of urban design through the understanding of temporality, density, infrastructure, and public space through the scale of a singular building within the context of a larger built environment. Focus will be given to the direct interaction with public agencies, community groups, developers, and community development corporations. The public orientation of the studios will provide an understanding of urban design as a fundamentally future-oriented practice with an expanded potential for engagement in the sociopolitical. Students will be able to select from varied studio topics. Open only to Architecture majors.

Corequisite(s): (ARCH 520) Prerequisite(s): [(ARCH 544)] (0-12-6)

ARCH 546

Studio VI: Comprehensive Building Design II

The development of an architectural project with an emphasis on comprehensive building design: advanced site development, spatial relationships between interior and exterior landscape, zoning and code analysis, programming, and fully integrated building systems. Study focuses on environmental concerns in building design. Studio work includes a comprehensive set of architectural documents, articulated model, and architectural details representative of the building's concepts. Open only to Architecture majors. Prerequisite(s): [(ARCH 545)]

(0-12-6)

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. Open only to Architecture majors. (3-0-3)

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. Open only to Architecture majors. (3-0-3)

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. Open only to Architecture majors. (3-0-3)

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. Open only to Architecture majors.

(3-0-3)

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. Open only to Architecture majors. (3-0-3)

ARCH 561

Entrepreneurship & 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. Open only to Architecture majors. (3-0-3)

ARCH 562

Planning Law & 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. Open only to Architecture majors. (3-0-3)

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. Open only to Architecture majors. (3-0-3)

ARCH 564

Comprehensive Opportunity Assessment & 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. Open only to Architecture majors. (6-0-6)

ARCH 565

Construction & 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. Open only to Architecture majors. (3-0-3)

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. Open only to Architecture majors. (3-0-3)

ARCH 588

Thesis Preparation Seminar

Seminars are conducted on thesis development and preparation with emphasis placed on language, the written form, thesis manual requirements, drawing and model presentation, and the oral presentation for jury examination. Open only to Architecture majors. (3-0-3)

ARCH 589

Pre-Thesis Seminar

An introduction to the architecture faculty through a discussion of current issues and future directions of the profession. These concerns are then related to the student's interest and the specialized experience of the faculty. 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. Together, they identify the Thesis Project, program, its scope and objective and, most important, budget time for each phase. Open only to Architecture majors. (3-0-3)

ARCH 590

Specialized Research & 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) Open only to Architecture majors. (Credit: Variable)

ARCH 591

Research & Thesis

A thesis project is developed in depth by the student under the direction of the adviser and an advisory committee of other architecture faculty and/or professional members. 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. After final acceptance of the presentation materials by the advisory committee, the text, reductions of the drawings, and model photographs are bound together in a hard-cover volume, which is deposited in the GRC and the university's library. (Credits: Variable, minimum total eight semester hours). Open only to Architecture majors.

(Credit: Variable)

ARCH 593 Master's Proi

Master's Project

The Master's Project is the culmination of both the twoyear 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 Successful Master's project proposals will be systems. 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. Open only to Architecture majors.

Prerequisite(s): [(ARCH 523)] (0-12-6)

ARCH 594

Research Problems Research problems. (Credit: Variable)

ARCH 596

ARCH IPRO IPRO. (0-0-3)

ARCH 597

Special Problems Open only to Architecture majors. (Credit: Variable)

ARCH 600

Continuance of Residence Continuance of residence. (0-1-1)

ARCH 601

Doctoral Methodology Pre-Seminar

This course provides a foundation for doctoral students in the diversity of research paradigms in architecture. The first component is an introduction to philosophy of knowledge with an emphasis on architecture. The second component entails a critical review and evaluation of diverse research methodologies in current doctoral architectural research. It is intended to provide substantial information on research methodologies not covered in undergraduate and graduate education. In this course students will write a series of papers that critically review the course readings and discussions. Open only to Architecture majors. (3-0-3)

ARCH 611

Seminar in Theory & 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. Open only to Architecture majors.

(3-0-3)

ARCH 612

Seminar in Theory & 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. (3-0-3)

ARCH 691

Doctoral Research

Open only to Architecture majors. (Credit: Variable)

Landscape Architecture

LA 501

Nature of Ecology

An historical, theoretical, and scientific account of nature's role in the humanities and sciences as they relate to design. Emphasis is placed on the relationships between natural systems and the fitness of a landscape, the site and the organism, open and closed systems, causation and constraints, sustainability, and the complex interplay between humans and the designed environment. Open only to Architecture majors. (3-0-3)

LA 502

Landscape Architectural History: From Antiquity to Olmsted

The chronological history of landscape design from antiquity to Olmsted, with emphasis on garden and park typologies. Open only to Architecture majors. (3-0-3)

LA 503

Advanced Contemporary Theory: Case Studies

The study of 20th century landscape design with an emphasis on the Prairie School, modernism, organicism, and contemporary trends. The course is split between lecture and in-depth case studies of significant landscapes from the Chicago region and beyond. Collection information from the study projects' authors and weekend site visits will lead to models and representations (drawings, videos, etc.) that reveal otherwise latent aspects of each study project's organization, perceptual character, appearance, and performance. Open only to Architecture majors. (3-0-3)

LA 514

Professional Practice of Landscape Architecture

An introduction to landscape architecture as a profession. Lectures, research assignments, and case studies will address issues including firm practice types, proposals and contracts, schedule and budget, project phases, project and client types, project team structure, the role of competitions, and professional development and licensure. Open only to Architecture majors.

(3-0-3)

LA 515 Firms, Parks, Developers

The players who orchestrate and manage landscapes, including planners, landscape architects, trusts, governmental agencies, and developers; and their economic, professional, political, and socio-cultural concerns and responsibilities. Open only to Architecture majors. (3-0-3)

LA 516

Historic Landscape Preservation

Survey of historic landscape preservation theory, method, and practice, and their relationship to environmental and cultural considerations. Open only to Architecture majors. (3-0-3)

LA 525

Representing & Modeling the Landscape

Using hand drawing and physical modeling to explore and interrogate landscape processes. Techniques and methods to explore, develop, and envision ideas particular to landscape design. Mapping, time, movement, body in space, line, contour, texture, flows of materials (hydro, litho, aero), and plant communities. Open only to Architecture majors. (3-0-3)

LA 526

Digital Media

Using digital tools to clarify, conceptualize, represent, and communicate the forces and flows within 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. Focus on Photoshop, Illustrator, and AutoCAD. Open only to Architecture majors. Prerequisite(s): [(LA 525)]

(3-0-3)

LA 527

Advanced Modeling & Fabrication

Students learn advanced digital fabrication and modeling techniques necessary to understand complex threedimensional surfaces, objects, and space, as well as dynamic processes. Modeling, rendering, scripting, and animation skills are used to conduct, generate, and communicate research. Open only to Architecture majors.

Prerequisite(s): [(LA 525 and LA 526)]

(3-0-3)

LA 541

Studio I: Dynamics & Processes of Place

Understanding the fundamental relationships of dynamic natural processes, with an emphasis on representing time, movement, space, light, natural rhythms, shifting boundaries and enclosures, and the physical materials of landscape. Within a "natural" setting, students use varied tools (including the body) to measure and record landscapespecific phenomena and conditions such as erosion, entropy, edges, and movement through dynamic spaces. Students develop insightful and appropriately precise methods of modeling and representing these phenomena. Open only to Architecture majors. (0-12-6)

LA 542

Studio II: Site & City

Introduction to ecosystems and how human interaction affects them. Emphasis on the Midwestern prairie and forest biome's wildlife, vegetation, climate, water, and aquatic ecosystems. Effects of human land use patterns on the land and on plant communities, and how they can be altered. Techniques and terms used by environmentalists and instruction in conducting a baseline ecosystem study. Open only to Architecture majors.

(0-12-6)

LA 543

Studio III: Comprehensive Landscape Design

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 and common design standards including ADA and Barrier-Free regulations. Open only to Architecture majors.

Prerequisite(s): [(LA 542)] (0-12-6)

LA 544

Studio IV: Site, City, & Region

Continuing investigation of native woody species as a major element in the landscape and traditional plant configurations such as bosques and allies in the built environment. Further study of native perennials and appropriate non-natives. Segment on use of annual and tropical plants within a design; container plantings as accents. Criteria for development of planting design and plant list, as well as plant selection, and technical aspects including hardiness zones, and soil requirements. Open only to Architecture majors. (0-12-6)

LA 545

Studio V: Advanced Landscape Design Investigations

Integration of large-scale site, programming, planting design, ecology of site, and other design elements and problems into a cohesive design solution. Practical application of the relationship among sites, drawings, and the making of landscape architectural projects. The semester is sequenced: site analysis; programming decisions; site modeling; development of design; representation and defense of design graphically (plan and elevation views), model, and materials and planting list. Design of environments which are responsive to human need and expressive physiographic conditions. Open only to Architecture majors. (0-12-6)

LA 546

Studio VI: Advanced Landscape Design Investigations

Critical synthesis of complex environmental, regulatory, and cultural conditions with multi-faceted programs demanding a mastery of knowledge, skill, and technique appropriate for a graduating student. Open only to Architecture majors. (0-12-6)

LA 565

Ecology & Materials Workshop I: Plants & 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 (natural and anthropogenic). Open only to Architecture majors. (2-2-3)

LA 566

Ecology & Materials Workshop II: Earthworks & Infrastructures The qualities and characteristics of "soft" and "hard" landscape materials with emphasis on a quantitative and interrelated understanding of landform (grading) and drainage design. Covers the influence of climate, geology, soils, hydrology, and disturbances on the design of a site's constituent elements including pathways and roads, infrastructure, plantings, and storm water management strategy. Open only to Architecture majors. (2-2-3)

LA 567

Ecology & Materials Workshop III: Horticulture & Design

Advanced understanding of horticulture as a technical science. The relationship between ecological research and a designed and engineered site, and applications thereof. Open only to Architecture majors.

(2-2-3)

LA 568

Ecology & Materials Workshop IV: Manufacturing 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. Overview of relevant sit-specific codes and environmentally oriented building programs such as LEED. Open only to Architecture majors.

(2-2-3)

Department of Biological and Chemical Sciences

Life Sciences Building 3101 S. Dearborn St. Chicago, IL 60616 312.567.3480 www.iit.edu/csl/bcs

Acting Chair: Grant Bunker

Executive Associate Chair for Biology: Thomas Irving

Associate Chair for Biology Tanya Bekyarova **Executive Associate Chair for Chemistry** M. Ishaque Khan

Associate Chair for Chemistry Maria Tanner

The Department of Biological and Chemical Sciences offers B.S., M.S., and Ph.D. degrees in the fields of chemistry, 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.

Degrees Offered

In Biology

Professional Science Master of Biology with specialization in:

Biochemistry Biotechnology Cell and Molecular Biology Microbiology Master of Science in Biology with specialization in: Biochemistry Biotechnology Cell and Molecular Biology Microbiology

Certificate Programs

In Chemistry Analytical Method Development Analytical Spectroscopy Characterization of Inorganic and Organic Materials

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 biochemistry, biotechnology, cell and molecular biology, microbiology, molecular biophysics and biochemistry; analytical chemistry, inorganic chemistry, materials chemistry, organic chemistry, polymer chemistry, surface chemistry, physical chemistry, and medicinal chemistry. The department constructs and operates facilities for x-ray scattering, spectroscopy, and imaging at the Advanced Photon Source at Argonne National Laboratory. Additional research facilities include on-campus Master of Science in Molecular Biochemistry and Biophysics Doctor of Philosophy in Biology Doctor of Philosophy in Molecular Biochemistry and Biophysics

In Chemistry

Master of Chemistry Master of Chemistry in Analytical Chemistry Master of Chemistry in Materials Chemistry Master of Science in Chemistry Doctor of Philosophy in Chemistry

Chromatography Synthesis and Characterization of Inorganic Materials Synthesis and Characterization of Organic Materials

x-ray diffraction facilities, thin-film growth facilities, a high-field nuclear magnetic resonance facility, state-ofthe-art inorganic-, organic- and polymer synthesis and characterization laboratories, Fourier transform infrared spectrometers, atomic force microscope, mass spectrometers, and facilities for high-pressure liquid chromatography and gas chromatography. Collaborative programs are carried on with Fermi National Accelerator Laboratory, Argonne National Laboratory, and the Advanced Photon Source.

Faculty

Biology Faculty

Antipova, Olga, Research Assistant Professor. B.Sc., M.S., Nizhny Novgorod Technical University (Russia); Ph.D., Illinois Institute of Technology. Research interests: contact faculty member.

Bekyarova, Tanya I., Senior Lecturer and Associate Chair of Biology. M.S., University of Plovdiv (Bulgaria); Ph.D., Illinois Institute of Technology. Muscle contraction and regulation. Biology and Biophysics.

Burton-Freeman, Britt, Research Assistant Professor of Biology and Director of the Nutrition Center at the Institute for Food Safety and Health. BS California State University; M.S., Ph.D. University of California-Davis. Appetite and obesity management and vascular disease. Research emphasizes on the effects of bioactive food components on mechanistic and behavioral processes of food intake and body weight regulation. Properties of fibers, micro- and macro-molecule interactions, and food matrix effects in the gut to alter metabolic and endocrine systems. Effects of dietary constituents on vascular diseases including evaluation of endothelium function, platelet activation, inflammatory and oxidative stress responses during acute and chronic interventions. The research approach includes human and basic science methodology.

Dushay, Mitchell, Assistant Professor. B.A., Brown University; Ph.D., Brandeis University. Drosophila genetics, immunology, eukaryotic transcription. Cell and Molecular Biology.

Edirisinghe, Indika, Research Assistant Professor and Senior Scientist of the Nutrition Center at the Institute for Food Safety and Health. B.Sc., University of Delphi (India); M.Phil., Ph.D., University of Peradeniya (Sri Lanka). Effect of polyphenolic compounds on endothelial function, blood pressure regulation, platelet function, insulin resistance, inflammatory and oxidative stress responses during acute and chronic interventions. The research approach includes human cell culture, animal models and human clinical trials.

Grove, Stephen F., Research Assistant Professor of Biology and Scientist at the Institute for Food Safety and Health. B.App.Sci. & B.App.Sci. (Hons.), RMIT University (Australia); Ph.D, University of Tasmania (Australia). Microbial food safety; fresh produce and sprout safety; cross-contamination, inactivation and detection of enteric viruses during food processing and handling; use of novel processing and sanitation techniques for fresh-cut produce; and survival and inactivation of bacterial pathogens in low moisture foods.

Howard, Andrew, Associate Professor of Biology and Physics. B.A., Pomona College; Ph.D., University of California-San Diego. Methods development and macromolecular crystallography. Biochemistry, Molecular Biochemistry, and Biophysics. Irving, Thomas C., Professor of Biology, Physics, and Biomedical Engineering and Executive Associate Chair, Biology - Biological and Chemical Sciences. B.Sc., M.Sc., Ph.D., University of Guelph (Canada). Structure and biophysics of macromolecular systems, muscle structure and physiology, synchrotron radiation instrumentation. Biochemistry, Molecular Biochemistry, and Biophysics.

Krikorian, Charles, Senior Lecturer and Director of Master's Program. B.S., University of Illinois, Urbana-Champaign; Ph.D., Loyola University; J.D., DePaul University.

Lee, Alvin, Research Associate Professor of Biology and Director of Microbiology at the Institute for Food Safety and Health. B.App.Sci., Ph.D, RMIT University (Australia). Microbial food safety, food virology, molecular detection and quantification of enteric pathogens; molecular characterization of virulence mechanisms, cell culture, intervention strategies for foodborne pathogens.

McCormick, David L., IITRI Professor, Senior Vice President and Director, IIT Research Institute. B.A., Middlebury College; Ph.D., New York University. Preclinical development of drugs for the prevention and therapy of cancer. Cell and Molecular Biology.

Mehta, Rajendra, Professor of Biological Sciences and Head, Carsinogenesis and Chemoprevention, IIT Research Institute. B.S., M.S., Gujurat University (India); Ph.D., University of Nebraska. Efficacy and mechanism of action of chemopreventive agents in experimental carcinogenesis of breast, colon, lung, and prostate. Cell and Molecular Biology.

Menhart, Nicholas G. , Associate Professor. B.Sc., Ph.D., University of Waterloo (Canada). Spectroscopic techniques for the study of multi-domain proteins. Biochemistry, Molecular Biochemistry, and Biophysics.

Orgel, Joseph, Associate Professor. B.Sc.(Hons.), Ph.D., Stirling University. Extracellular matrix function and structure, protein folding.

Spink, Kathryn M., Senior Lecturer and Chair of the Pre-Medical Advisory Committee. B.S., Michigan Technological University; Ph.D., Michigan State University. Molecular genetics of mammalian viruses. Cell and Molecular Biology, Microbiology.

Stark, Benjamin C., Professor. B.S., University of Michigan; M.Ph., Ph.D., Yale University. Biochemistry and molecular biology of bacterial respiration, fermentation, bioremediation. Microbiology, Biotechnology, Cell and Molecular Biology. Wan, Jason, Research Professor and Director of Education and International Outreach at the Institute for Food Safety and Health. B.S., Hunan University; M.S., Northeast Agricultural University; Ph.D., Deakin University (Australia). Molecular microbiology including development of DNA-based methods for detection, differentiation and tracking of foodborne pathogens in food systems and environment. Emerging nonthermal processing technologies, including high pressure processing (HPP), pulsed electric field (PEF), ultrasound, UV and non-thermal plasma, for microbial inactivation, shelf-life extension and food safety enhancement. Dairy processing, protein chemistry, and development and evaluation of bioactive dairy ingredients for functional food applications.

Webster, Dale A., Emeritus and Research Professor. B.S., University of Michigan; Ph.D., University of California, Berkeley. Biochemistry and molecular biology of bacterial respiration, biotechnology and bioremediation. Biochemistry, Microbiology, Biotechnology. Xiang, Jialing, Associate Professor. M.D., Xuzhou Medical College; Ph.D. University of Alabama-Birmingham. Molecular mechanisms of cancer and cancer gene therapy. Cell and Molecular Biology.

Zhang, Chunbo, Research Assistant Professor. B.Agr., M.Agr., Zhejiang Fisheries College (China); Ph.D., University of Manitoba (Canada). Use of molecular genetics, biophysics, immunohistochemistry, pharmacology, and behavior to study olfactory transduction in the mouse and in fish. Cell and Molecular Biology.

Zhang, Wei, Associate Professor. B.S., M.S., Huazhong Agricultural University; Ph.D., Pennsylvania State University. Molecular detection, genotyping, epidemiology, virulence and pathogenesis of foodborne bacteria. Microbiology, Biotechnology.

Chemistry Faculty

Cage, Brant, Assistant Professor. B.S., University of West Florida; Ph.D., Florida State University. Synthesis and biophysical applications of magnetic materials, design and building sensitive instrumental techniques to characterize magnetic materials; theoretical analysis of novel materials with superior properties for particular needs, such as magnetic resonance imaging (MRI) enhancement, magnetic refrigeration, and standards for MRI.

Chong, Hyun-soon, Associate Professor. B.S., M.S. Kyung-Hee University; Ph.D. University of North Texas. Synthetic and mechanistic organic chemistry, macrocyclic chemistry, cancer therapeutics and diagnostics, medicinal chemistry, bioorganic and bioinorganic chemistry, biologically active synthetic and natural products, heterocyclic chemistry, molecular recognition studies, nanobiotechnology.

Eisenberg, Walter C., Emeritus Professor. B.S. University of Toronto (Canada); M.S., Rochester Institute of Technology; Ph.D., University of Buffalo. Organic-, oxidant and single oxygen chemistry, biochemistry, air pollution, polycyclic aromatic hydrocarbon transformation, analytical methods development, professional graduate education.

Filler, Robert, Emeritus Professor, Senior Research Fellow. B.S., City College of New York; Ph.D., University of Iowa. Heterocyclic compounds, effects of fluorine in fluorine-containing compounds.

Guan, Xiyun (Richard), Associate Professor. B.S., China University of Geosciences; M.S., Chinese Academy of Geological Sciences; Ph.D., University of Kentucky. Bioanalytical and bio-physical chemistry with an emphasis on the development of biosensors for bio-terrorist/biodefense chemicals, environmental pollutants, toxins, DNA and protein molecules.

Hock, Adam S., Assistant Professor. B.S., University of Delaware; Ph.D., Massachusettes Institute of Technology. Homogenous and heterogenous inorganic and organometallic synthesis and catalysis; rational and tunable methods for the preparation of light-harvesting and novel electronic materials; structure, bonding, and electronic properties of molecular and extended materials.

Johnson, Peter Y., Emeritus Professor. B.S., University of Illinois, Urbana-Champaign; Ph.D., Massachusetts Institute of Technology. Syntheses of penicillin related compounds; photochemical and/or transannular reactions. Khan, M. Ishaque, Professor and Executive Associate Chair - Chemistry, Department of Biological and Chemical Sciences. Ph.D., Indian Institute of Technology (India). Design, synthesis, and property studies of advanced materials. Current focus is on nanomaterials for applications in chemical sensing, energy storage, and biomedical usage, and nanostructured catalysts for detection and removal of toxic gases from industrial exhaust and flue gas streams, selective oxidation, (hydrocarbon's transformation into useful industrial feed-stocks), and hydro treating catalysis.

Lykos, Peter, Professor. B.S., Northwestern University; Ph.D., Carnegie Institute of Technology. Physical chemistry, standards for undergraduate chemistry and chemistry curricula, combination theoretical (Hartree Fock) and experimental (synchrotron radiation) determination of correlation energy, semi-empirical methods in quantum chemistry, computer applications in chemistry.

Mandal, Braja K., Professor. B.Sc., University of Calucutta (India); M.Sc., M.Tech., Ph.D., Indian Institute of Technology (India). Polymer science and engineering, electroactive materials, phthalocyanines and porphyrins, solid polymer electrolytes, lithium battery materials.

Nguyen, Diep, Industry Professor. B.S., Ph.D., McGill University. Characterization and study of structureproperty relationships in industrial polymeric materials.

Schug, Kenneth, Professor Emeritus. B.S., Stanford University; Ph.D., University of Southern California. Chemical education, coordination compounds of transition metals emphasizing chemical reactivity of ligands, enhancement programs for K12 teachers, minority medical students programs, research opportunities for high school students.

Tanner, Martha (Maria), Lecturer and Associate Chair of Chemistry, Department of Biological and Chemical Sciences. B.S., University of Illinois, Urbana-Champaign; M.A., Seattle University; Ph.D., University of North Carolina. Chemical education, science communication, organometallics, catalysis and polymer synthesis.

Unni, Aditya K., Assistant Professor. B.A., St. Olaf College; Ph.D., University of Chicago. Synthesis of small molecule natural products with interesting structural characteristics and biological activities. Developing reactions, specifically in asymmetric catalysis, to access high value chemical building blocks for organic synthesis. Wang, Rong, Associate Professor. B.S., M.S., Jilin University (China); Ph.D., University of Tokyo (Japan). Scanning probe microscopy, bioconjugate chemistry, biocompatible materials, method of development for single cell characterization and manipulation, analysis of effects of microenvironments on protein/cell/tissue function and dynamics. Zion, Benjamin, Lecturer. B.A., Lawrence University; Ph.D., University of Chicago. Reactions at surfaces. Current focus is on chemical education and course development with special attention to instrumentation.

Admission Requirements

Cumulative undergraduate GPA minimum: 3.0/4.0 TOEFL minimum: $550/213/80^*$

The Graduate Record Examination (GRE) is required for all applicants. The GRE minimum scores are:

- Ph.D.: 310 (quantitative + verbal),
- 3.0 (analytical writing) M.S.: 300 (quantitative + verbal),
- 2.5 (analytical writing)
- MAS: 300 (quantitative + verbal),
- 2.5 (analytical writing)
- MCH: 900 (quantitative + verbal),
- 2.5 (analytical writing)

Applicants to the doctoral program in chemistry are strongly encouraged to submit the subject-area GRE score (Subject No. 27). 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.

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 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, Chemistry, 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 MCH, MAS, and M.S. comprehensive/Ph.D. qualifying examination.

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

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.

All students in the professional master's degree programs (MAS) are required to take and pass a comprehensive exam. Students may sit for the exam a limited number of times, depending upon the individual program.

Biology

The department offers graduate programs leading to Master of Biology and to M.S. and Ph.D. degrees in biology, concentrating educational and research activities in the areas of biochemistry, biotechnology, 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

Master of Biology

Minimum 30 credit hours Comprehensive examination

The Professional Master of Biology is a course-only, professional master's degree program designed for professionals who seek advanced and specialized study in the field without the requirement of a thesis or project.

This program is also available on the Web, and at televised viewing sites throughout the Chicago area. Students should consult http://iit.edu/iit_online/ for more information.

Students must pass the written comprehensive examination (see Departmental Graduate Examinations) in their respective areas of specialization: biochemistry, cell and molecular biology, or microbiology. Students in biotechnology may choose any of the three examinations. The program consists of a minimum of 30 credit hours of coursework as follows.

Cell and Molecular Biology

BIOL 401 Introductory Biochemistry AND BIOL 402 Metabolic Biochemistry OR. **BIOL 504** Biochemistry Lectures BIOL 544 Molecular Biology of Cells BIOL 515 Molecular Biology BIOL 526 Developmental Biology AND 6-9 hours of approved electives Microbiology BIOL 401 Introductory Biochemistry AND

BIOL 402 Metabolic Biochemistry OR. BIOL 504 Biochemistry Lectures BIOL 544 Molecular Biology of Cells BIOL 515 Molecular Biology BIOL 542 Advanced Microbiology AND 6-9 hours of approved electives

they may be completed by part-time students. Doctorallevel courses are usually available either in the evenings, on Saturdays, or on the internet. Each new graduate student is assigned a graduate student advisor and must obtain the approval of the advisor each semester before registering for any graduate classes.

Biochemistry

BIOL 401 Introductory Biochemistry AND BIOL 402 Metabolic Biochemistry OR. **BIOL 504** Biochemistry Lectures BIOL 512 Advanced Biochemistry BIOL 544 Molecular Biology of Cells BIOL 515 Molecular Biology **AND** 6-9 hours of approved electives Biotechnology BIOL 401 Introductory Biochemistry AND BIOL 402 Metabolic Biochemistry OR. **BIOL 504** Biochemistry Lectures BIOL 544 Molecular Biology of Cells BIOL 515 Molecular Biology **BIOL 562** Functional Genomics **AND** 6-9 hours of approved electives Students in each area of specialization also take the following three courses: CHEM 513 Statistics for Analytical Chemists AND COM 421 Technical Communications OR COM 523 Communicating Sciences COM 580 Communication in Organizations AND **BIOL 511** Project Management OR INTM 511 Industrial Leadership OR. BIOL 524 Science and Law: An Introduction to

Intellectual Property Law and Patents

Master of Science in Biology

32-34 credit hoursComprehensive examinationOption 1: ThesisOption 2: Library or Laboratory research project

A Master of Science student must complete 32-34 credit hours of approved graduate work in one of the areas of specialization detailed below. This will include 26-30 credit hours of coursework and one credit hour of BIOL 595 Colloquium. Two options are available to complete

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 the M.S. degree requirements: a thesis option and a nonthesis option.

Students must pass the written M.S. comprehensive examination (see Departmental Graduate Examinations) in their respective areas of specialization: biochemistry, cell and molecular biology, or microbiology. Students in biotechnology may choose any of the three examinations.

must complete six credit hours of thesis research (BIOL 591). Students must also prepare a written thesis based on laboratory research.

Non-Thesis Option

The non-thesis option is intended as a degree to meet the needs of teachers, science administrators, policy makers in the life sciences, patent attorneys and others.

Students who elect the non-thesis option must complete a library research project in one of the following courses: BIOL 572 (Literature in Biochemistry), BIOL 574 (Literature in Biotechnology), BIOL 576 (Literature in Cell and Molecular Biology), or BIOL 578 (Literature in Microbiology); or a laboratory research project in BIOL 522 (Research Techniques in the Biological Sciences I) plus BIOL 523 (Research Techniques in Biological Sciences II).

Master of Science in Biology with Specialization in Biochemistry

32 credit hours

Required Courses (19 hours)

- BIOL 501 Graduate Laboratory Techniques
- BIOL 544 Molecular Biology of Cells
- BIOL 504 Biochemistry Lectures
- BIOL 512 Advanced Biochemistry
- BIOL 515 Molecular Biology
- BIOL 533 Advanced Graduate Laboratory Techniques
- BIOL 555 Macromolecular Structure Determination

Additional Requirements (7 hours)

BIOL 595 Colloquium AND BIOL 591 Research OR BIOL 591 Research OR BIOL 572 Literature in Biochemistry AND one additional elective OR BIOL 522 Research Techniques in Biological Sciences AND

BIOL 523 Research Techniques in Biological Sciences 2

Elective Courses (6 hours)

- BIOL 410 Medical Microbiology BIOL 426 Cancer Biology
- DIOL 420 Cancer Blology
- BIOL 430 Animal Physiology
- BIOL 503 Virology
- BIOL 514 Toxicology
- BIOL 520 Laboratory Rotation
- BIOL 526 Developmental Biology
- BIOL 527 Immunology and Immunochemistry
- BIOL 542 Advanced Microbiology
- BIOL 545 Advanced Cell Biology
- BIOL 550 Bioinformatics and Biotechnology
- BIOL 562 Functional Genomics

Other requirements are identical to those described previously for all M.S. students in biology. The requirements for admission to this program include one year of physical chemistry in addition to the usual requirements for admission to graduate study in biology.

Master of Science in Biology with Specialization in Biotechnology

32-34 credit hours

Required Courses (19-21 hours)

BIOL 501	Graduate Laboratory Techniques
BIOL 544	Molecular Biology of Cells
BIOL 504	Biochemistry Lectures
OR	
BIOL 401	Introductory Biochemistry AND
BIOL 402	Metabolic Biochemistry
BIOL 515	Molecular Biology
BIOL 533	Advanced Graduate Laboratory Techniques
BIOL 550	Bioinformatics and Biotechnology
BIOL 562	Functional Genomics
Additional	Requirements (7 hours)
BIOL 595	Colloquium AND
BIOL 591	Research
OR	
BIOL 574	Literature in Biotechnology AND one

Elective Courses (6 hours) BIOL 410 Medical Microbiology BIOL 426 Cancer Biology

BIOL 430 Animal Physiology BIOL 503 Virology **BIOL 512** Advanced Biochemistry BIOL 514 Toxicology BIOL 520 Laboratory Rotation BIOL 521 Advanced Micro-Genetics Laboratory **BIOL 526** Developmental Biology BIOL 527 Immunology and Immunochemistry BIOL 542 Advanced Microbiology BIOL 545 Advanced Cell Biology BIOL 555 Macromolecular Structure

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

OR

AND

Required Courses (19-21 hours)

additional elective

BIOL 522 Research Techniques in Biological Sciences

BIOL 523 Research Techniques in Biological Sciences 2

BIOL 501 Graduate Laboratory Techniques BIOL 544 Molecular Biology of Cells BIOL 504 Biochemistry Lectures OR BIOL 401 Introductory Biochemistry AND BIOL 402 Metabolic Biochemistry BIOL 515 Molecular Biology BIOL 526 Developmental Biology BIOL 533 Advanced Graduate Laboratory Techniques BIOL 545 Advanced Cell Biology

Additional Requirements (7 hours)

- BIOL 595 Colloquium AND BIOL 591 Research OR BIOL 576 Literature in Cell Biology AND one additional elective OR BIOL 522 Research Techniques in Biological Sciences AND
- BIOL 523 Research Techniques in Biological Sciences 2

Elective Courses (6 hours) BIOL 410 Medical Microbiology BIOL 426 Cancer Biology BIOL 430 Animal Physiology BIOL 503 Virology **BIOL 512** Advanced Biochemistry BIOL 514 Toxicology BIOL 520 Laboratory Rotation BIOL 527 Immunology and Immunochemistry BIOL 542 Advanced Microbiology BIOL 550 Bioinformatics and Biotechnology BIOL 555 Macromolecular Structure **BIOL 562** Functional Genomics

Other requirements are identical to those described previously for all M.S. students in biology.

Master of Science in Biology with Specialization in Microbiology

32-34 credit hours

Required Courses (22-24 hours)

BIOL 501	Graduate Laboratory Techniques
BIOL 544	Molecular Biology of Cells
BIOL 503	Virology
BIOL 504	Biochemistry Lectures OR
BIOL 401	Introductory Biochemistry
AND	
BIOL 402	Metabolic Biochemistry
BIOL 515	Molecular Biology
BIOL 533	Advanced Graduate Laboratory Techniques
BIOL 542	Advanced Microbiology
BIOL 562	Functional Genomics

Additional Requirements (7 hours)

Colloquium AND
Research
Literature in Microbiology \mathbf{AND} one
additional elective
Research Techniques in Biological Sciences
Research Techniques in Biological Sciences 2

Elective Courses (3 hours)

BIOL 410 $$	Medical Microbiology
BIOL 426	Cancer Biology
BIOL 430	Animal Physiology
BIOL 512	Advanced Biochemistry
BIOL 514	Toxicology
BIOL 520 $$	Laboratory Rotation
BIOL 526	Developmental Biology
BIOL 527	Immunology and Immunochemistry
BIOL 545	Advanced Cell Biology
BIOL 550 $$	Bioinformatics and Biotechnology

BIOL 555 Macromolecular Structure

Other requirements are identical to those described previously for all M.S. students in biology.

Doctor of Philosophy in Biology

84 credit hours Written qualifying examination Comprehensive examination Dissertation and oral defense

A minimum of 84 credit hours is required for the Ph.D. degree in biology. Students should consult the Transfer Credit section 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. qualifying examination in their respective areas of specialization: biochemistry, cell and molecular biology, or microbiology (see Departmental Graduation Examinations).

Each student, in addition, will be required to pass a comprehensive examination taken prior to performing the major portion of the dissertation research, and in any event, prior to the sixth semester of study and at least one year before oral defense of the thesis. The final examination for the Ph.D. degree consists of an oral presentation and defense of the dissertation.

The Ph.D. program is tailored to fit the student's background and goals and is subject to approval at the time of filing of the program of study (Form 401). Programs of study may be designed in any of the three areas of concentration. However, all programs of study must include at least 36 credit hours in formal courses (exclusive of BIOL 591 and BIOL 691).

Formal courses must include the core courses listed below:

Required Courses

BIOL 544 Molecular Biology of CellsBIOL 504 Biochemistry LecturesBIOL 515 Molecular BiologyBIOL 595 Biology Colloquium (4 times)

Elective Courses

BIOL 410	Medical Microbiology
BIOL 426	Cancer Biology
BIOL 430	Animal Physiology
BIOL 501	Graduate Laboratory Techniques
BIOL 503	Virology
BIOL 514	Toxicology
BIOL 520 $$	Laboratory Rotation
BIOL 521	Advanced Micro Genetics Laboratory
BIOL 526	Developmental Biology
BIOL 527	Immunology and Immunochemistry
BIOL 533	Advanced Graduate Laboratory Techniques
BIOL 539	Advanced Cell Biology Laboratory
BIOL 542	Advanced Microbiology
BIOL 545	Advanced Cell Biology
BIOL 550	Bioinformatics and Biotechnology
BIOL 555	Macromolecular Structure
BIOL 562	Functional Genomics
BIOL 584	Graduate Seminar in Biology
BIOL 597	Special Topics
PHYS 410	Molecular Biophysics

All research for the dissertation must be carried out under the direct supervision of a faculty research advisor. The faculty research advisor will also act as the candidate's academic advisor. Students must have passed the written qualifying examination before registering for BIOL 691 (Ph.D. Thesis Research). Students may complete all formal course requirements for the Ph.D. degree as either full-time or part-time students.

Molecular Biochemistry and Biophysics (MBB)

The department offers interdisciplinary programs leading to M.S. and Ph.D. degrees in molecular biochemistry and biophysics. New advances in our understanding of biological function can be expected from a synthesis of molecular genetics, biochemistry and insights gained from molecular structural information. Individuals with a quantitative, physical approach will be best placed to be innovators in the field. MBB programs complement more traditional graduate programs in biology, chemistry, and physics by offering an integrated, molecularbased approach to understanding biological problems, taking insights from all three disciplines. A major focus of the program is on biophysical approaches to determining the structure of macromolecules and macromolecular assemblies. Faculty advisors are chosen from any of the participating departmental faculty regardless of their affiliation to a particular discipline; a particular strength of the participating faculty is in exploiting synchrotron x-ray sources for biological structural studies. MBB students will have access to state-of-the-art x-ray facilities at the nearby Advanced Photon Source, currently one of the most intense x-ray sources in the world.

Master of Science in Molecular Biochemistry and Biophysics

32 credit hours Comprehensive examination Option 1: Thesis Option 2: Library or Laboratory research project

A master's student must complete 32 credit hours of approved graduate work, including a core of 22 credit hours, 1 hour of BIOL 595 (Colloquium), 3 credit hours of approved electives, and 6 credit hours of research toward the thesis (BIOL, CHEM, or PHYS 591); or BIOL 572 (Literature in Biochemistry) and one additional elective, or BIOL 522 (Research Techniques in the Biological Sciences), and 3 credit hours of BIOL 597 (Special Topics).

Required Courses (22 hours)

- BIOL 501 Graduate Laboratory TechniquesBIOL 544 Molecular Biology of CellsBIOL 504 Biochemistry LecturesBIOL 515 Molecular Biology
- BIOL 519 Biochemistry Laboratory
- OR
- BIOL 533 Laboratory in Cell and Molecular Biology
- BIOL 555 Macromolecular Structure Determination
- PHYS 410 Biophysics
- BIOL 512 Advanced Biochemistry Lectures

Additional Requirements (7 hours)

BIOL 595 Colloquium BIOL 591 Research OR CHEM 591 Research OR PHYS 591 Research OR BIOL 572 Literature in Biochemistry AND one additional elective OR BIOL 522 Research Techniques in Biological Sciences I AND

BIOL 523 Research Techniques in Biological Sciences II

Elective Courses (3 hours)

- BIOL 410 Medical Microbiology
- BIOL 426 Cancer Biology
- BIOL 430 Animal Physiology
- BIOL 503 Virology
- BIOL 514 Toxicology
- BIOL 520 Laboratory Rotation
- BIOL 526 Developmental Biology
- BIOL 527 Immunology and Immunochemistry
- BIOL 542 Advanced Microbiology
- BIOL 545 Advanced Cell Biology
- BIOL 550 Bioinformatics and Biotechnology
- BIOL 562 Functional Genomics

The elective is chosen in consultation with an academic advisor. Research for the dissertation must be carried out under the direct supervision of a participating faculty member; the faculty research advisor also acts as the candidate's academic advisor.

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, CHEM, or PHYS 591). Students must also prepare a written thesis based on laboratory research.
Non-Thesis Option

The non-thesis option is intended as a degree to meet the needs of teachers, science administrators, policy makers in the life sciences, patent attorneys, and others.

Students who elect the non-thesis option must complete a library research project in BIOL 572 (Literature in

Doctor of Philosophy in Molecular Biochemistry and Biophysics

84 credit hours Written qualifying examination Comprehensive examination Dissertation and oral defense

A minimum of 84 credit hours of instruction is required for the MBB Ph.D. Students should consult the section Transfer Credits on page 31 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 21 credit hours of core courses and at least five additional courses from the list of electives.

Each graduate student must take and pass the written Ph.D. qualifying examination in order to enter into candidacy for the doctorate. Each student, in addition, will be required to pass a comprehensive examination taken prior to performing the major portion of the dissertation research, and in any event, prior to the sixth semester of study and at least one year before oral defense of the thesis. The final examination for the Ph.D. degree consists of an oral presentation and defense of the dissertation.

The Ph.D. program is tailored to fit the student's background and goals and is subject to approval at the time of filing of the program of study (Form 401). The program of study must include at least 36 credt hours in formal courses (exclusive of BIOL 591 and BIOL 691).

All students will be required to take the following courses, or have equivalent background:

Required Courses

- BIOL 544 Molecular Biology of Cells
- BIOL 504 Biochemistry Lectures
- BIOL 512 Advanced Biochemistry
- BIOL 515 Molecular Biology
- BIOL 555 Macromolecular Structure Determination
- BIOL 584 Graduate Seminar in Biology
- BIOL 595 Biology Colloquium
- PHYS 410 Molecular Biophysics

Biochemistry), or a laboratory based research project in BIOL 522 (Research Techniques in the Biological Sciences) plus BIOL 523 (Research Techniques in Biological Sciences II).

MBB students, in consultation with their academic advisor, choose the remainder of their formal coursework from the following list of elective courses:

Elective Courses

BIOL 410	Medical Microbiology
BIOL 414	Genetics for Engineering Sciences
BIOL 426	Cancer Biology
BIOL 430	Animal Physiology
BIOL 503	Virology
BIOL 514 $$	Toxicology
BIOL 520 $$	Laboratory Rotation
BIOL 526	Developmental Biology
BIOL 527	Immunology and Immunochemistry
BIOL 533	Advanced Graduate Laboratory Techniques
BIOL 542	Advanced Microbiology
BIOL 545	Advanced Cell Biology
BIOL 550 $$	Bioinformatics and Biotechnology
BIOL 562 $$	Functional Genomics
BIOL 597	Special Topics
CHEM 538	Biophysical Chemistry

Other courses may be prescribed by the advisor/thesis committee according to the student's individual needs for the program of study. All research for the dissertation must be carried out under the direct supervision of a faculty research advisor who will also act as the candidate's academic advisor.

Chemistry

The department offers graduate programs leading to M.S. and Ph.D. degrees in chemistry. Each student's program is planned individually to meet individual needs, interests, and capabilities. In addition, the department offers two professional master's programs designed for the part-time student and available through distance learning. The aim of these programs is to develop chemists who are able to think creatively and critically. In recognition of the value of teaching experience in

Master of Chemistry in Analytical Chemistry

32 credit hours Comprehensive examination

The professional master's program in analytical chemistry is a part-time program for working chemists seeking to strengthen their understanding of analytical chemistry. The specific goal of the program is to provide the student with a broad and in-depth understanding of state-of-the-art analytical techniques with a firm grounding in separation science, spectroscopy, method development, and sample preparation. In addition, students acquire professional skills in effective communication, statistics, and business principles. Candidates must possess a bachelor's degree (ideally in science or engineering) with at least one semester of calculus, one semester of calculus-based physical chemistry, one semester of analytical chemistry, and two semesters of organic chemistry. Candidates' advisors assist them in determining if any further prerequisites are necessary. A final comprehensive exam is required for graduation. This program is also available via the internet. Students should consult www.iit.edu/csl/bcs for more information. strengthening an individual's understanding of his or her field of study and as an aid in making career decisions, the department requires all full-time Ph.D. students to participate in instructional activities.

Each new graduate student is assigned a graduate student advisor and must obtain the approval of the advisor each semester before registering for any graduate classes.

Required Courses

CHEM 500	Advanced Analytical Chemistry
CHEM 505	Spectroscopic Methods I
CHEM 506	Sampling and Sample Preparation
CHEM 508	Analytical Methods Development
CHEM 509	Physical Methods of Characterization
CHEM 512	Spectroscopic Methods II
CHEM 513	Statistics for Analytical Chemists
CHEM 515	Gas Chromatography - Theory and Practice
CHEM 516	Liquid Chromatography - Theory and
	Practice
AND one of	the following three courses:

CHEM 542 Polymer Characterization and Analysis

CHEM 543 Analytical Chemistry in Pharmaceutical Laboratories

CHEM 544 Colloids and Colloid Analysis

 $\ensuremath{\mathsf{AND}}$ two of the following three courses:

CHEM 511 Project Management

COM 523 Communicating Science

INTM 511 Industrial Leadership

Master of Chemistry

32 credit hours Comprehensive examination

A minimum of 32 credit hours is required for the Master of Chemistry degree. Students seeking the Master of Chemistry degree must pass the oral comprehensive examination in their area of specialization (as determined by the student's academic advisor) by the end of their fourth semester in the master of chemistry degree program. The comprehensive examinations are given in the following areas:

- Analytical Chemistry
- Biochemistry
- Inorganic Chemistry
- Organic Chemistry
- Polymer Chemistry
- Physical chemistry

The Master of Chemistry program is tailored to fit the student's background and goals and is subject to approval at the time of filing of the Program of Study (Form 401). Programs of study must include the following core courses.

Required Courses

CHEM 584 Graduate Seminar

CHEM 585 Colloquium in Chemistry (must be taken twice)

The required coursework includes a minimum of four core courses chosen from the following core courses. Each of the four core courses must be chosen from six different chemistry disciplines including analytical chemistry, biochemistry, inorganic chemistry, organic chemistry, physical chemistry, and polymer chemistry.

CHEM 455 Advanced Organic Chemistry OR CHEM 530 Organic Reaction Mechanisms CHEM 500 Advanced Analytical Chemistry OR CHEM 505 Spectroscopic Methods I CHEM 520 Advanced Inorganic Chemistry OR CHEM 521 Structural Inorganic and Materials Chemistry CHEM 550 Quantum Chemistry CHEM 470 Introduction to Polymer Chemistry OR CHEM 535 Polymer Synthesis BIOL 504 Biochemistry Lectures

There are 15 total course credit hours required by the chemistry program. The graduate college requires 20 course credit hours. The remainder of the program of study will be chosen in consultation with the student's advisor. Students can choose any of the elective courses in consultation with their academic advisor.

Master of Chemistry in Materials Chemistry

31 credit hours Comprehensive examination

The professional master's program in materials chemistry is a part-time program designed for scientists who wish to broaden their background in synthesis and characterization of materials and chemical systems and their properties. The program combines modern materials design and synthesis strategies with innovative characterization techniques, computational and simulation methods, environmental regulations, project management, technical communication, and intellectual property management. It is structured to provide students with opportunities to develop a broad and in-depth understanding of the state-of-the-art in materials synthesis and characterization, learn to design and manage projects, sharpen their intellectual property management techniques, learn how to operate under regulatory constraints, and to improve communication skills. Students have the option to concentrate in inorganic or organic materials, or polymers.

Candidates must have a bachelor's degree (ideally in science or engineering), with at least two semesters of organic chemistry and two semesters of calculus. The academic advisor assists students in determining whether any prerequisites are necessary. A final comprehensive examination is required for graduation. This program is also available on the Web, and at televised viewing sites throughout the Chicago area. Students should consult www.iit.edu/csl/che/ for more information.

Required Courses

CHEM 454	Chemical Modeling and Simulation
CHEM 505	Spectroscopic Methods I
CHEM 509	Physical Methods of Characterization
CHEM 511	Project Management/Business Principles
CHEM 521	Structural Inorganic and Materials
	Chemistry
CHEM 522	Efficient Chemical and Materials Synthesis
CHEM 524	Synthesis and Intellectual Property
	Management

COM 523 Communicating Science

Elective Courses (choose 3)

- CHEM 470 Introduction to Polymers
- CHEM 513 Statistics for Chemists
- CHEM 530 Organic Reactions and Mechanisms
- CHEM 531 Tactics in Organic Synthesis
- CHEM 535 Polymer Synthesis
- CHEM 542 Polymer Characterization and Analysis
- ENVE 545 Environmental Regulations and Risk
- Assessment PHYS 431 Nanoscience

Master of Science in Chemistry

32 credit hours Comprehensive examination Thesis and oral defense

A minimum of 32 credit hours is required for the M.S. in chemistry. Students seeking the Master of Science degree must pass the written comprehensive examination in their area of specialization, as determined by the student's thesis advisor, by the end of their fourth semester in the M.S. program. The comprehensive examinations are given in the following areas:

- Analytical Chemistry
- Biochemistry
- Inorganic Chemistry
- Organic Chemistry
- Physical chemistry
- Polymer Chemistry

The student must also 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 their 3rd year.

The M.S. program is tailored to fit the student's background and goals and is subject to approval at the time of filing of the Program of Study (Form 401).

Required Courses

- CHEM 584 Graduate Seminar
- CHEM 585 Colloquium in Chemistry (must be taken twice)

The required coursework includes a minimum of four core courses chosen from the following courses. Each of the four core courses must be chosen from six different chemistry disciplines including analytical chemistry, biochemistry, inorganic chemistry, organic chemistry, physical chemistry, and polymer chemistry.

CHEM 455 OB	Advanced Organic Chemistry
CHEM 530	Organic Reaction Mechanisms
CHEM 500	Advanced Analytical Chemistry
CHEM 505	Spectroscopic Methods
CHEM 520 OR	Advanced Inorganic Chemistry
CHEM 521	Structural Inorganic and Materials Chemistry
CHEM 550	Quantum Chemistry
CHEM 470 OR	Introduction to Polymer Chemistry
CHEM 535	Polymer Synthesis

BIOL 504 Biochemistry Lectures

There are 15 course credit hours total required by the chemistry program. The graduate college requires 20 course credit hours. The remainder of the program of study will be chosen in consultation with the student's advisor. Students can choose any of the elective courses in consultation with their academic advisor.

Doctor of Philosophy in Chemistry

84 credit hours Written qualifying examination Comprehensive examination Dissertation and oral defense

A minimum of 84 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 in their area of specialization (as determined by the student's thesis advisor) by the end of their fourth semester in the Ph.D. program. Ph.D. qualifying examinations are given in the following areas:

- Analytical Chemistry
- Biochemistry
- Inorganic Chemistry
- Organic Chemistry
- Physical chemistry
- Polymer Chemistry

The comprehensive examination will be taken and passed on each student's research progress and thesis proposal. A student must write a thesis proposal and present a research seminar on his or her thesis progress before their Ph.D. thesis committee. Students must pass the comprehensive exam before the end of their 3rd 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 advisor and the thesis committee.

The Ph.D. program is tailored to fit the student's background and goals and is subject to approval at the time of filing of the Program of Study (Form 401).

Required Courses

CHEM 550 Chemical Bonding CHEM 584 Graduate Seminar CHEM 585 Colloquium in Chemistry (must be taken twice) CHEM 684 Graduate Seminar CHEM 685 Colloquium in Chemistry

The required coursework includes a minimum of four core courses chosen from the following courses. Each of the four core courses must be chosen from six different chemistry disciplines including analytical chemistry, biochemistry, inorganic chemistry, organic chemistry, physical chemistry and polymer chemistry.

CHEM 455Advanced Organic Chemistry
OR
CHEM 530Organic Reaction MechanismsCHEM 500Advanced Analytical Chemistry
ORCHEM 505Spectroscopic Methods ICHEM 520Advanced Inorganic Chemistry
ORCHEM 521Structural Inorganic and Materials
ChemistryCHEM 550Quantum ChemistryCHEM 470Introduction to Polymer Chemistry
OR
CHEM 535

BIOL 504 Biochemistry Lectures

Certificate Programs - In Chemistry

Analytical Method Development

Required courses

CHEM 506 Sampling and Sample Preparation CHEM 508 Analytical Methods Development

Analytical Spectroscopy

Required Courses

CHEM 505 Spectroscopic Methods I CHEM 512 Spectroscopic Methods II

Chromatography

Required Courses

CHEM 515 Gas Chromatography - Theory and Practice CHEM 516 Liquid Chromatography - Theory and Practice **AND** two courses selected from the list of electives below.

AND two courses selected from the list of electives below.

AND two courses selected from the list of electives below.

Electives for Analytical Method Development, Analytical Spectroscopy, and Chromatography

CHEM 500	Advanced Analytical Chemistry	CHEM 512 $$	Spectroscopic Methods II
CHEM 515	Gas Chromatography - Theory and Practic	CHEM 513 $$	Statistics for Analytical Chemists
CHEM 516	Liquid Chromatography - Theory and	CHEM 542 $$	Polymer Charicterization and Analysis
	Practice	CHEM 543	Analytical Chemistry in Pharmaceutical
CHEM 505	Spectroscopic Methods		Sciences
CHEM 506	Sampling and Sample Preparation	CHEM 544	Colloids and Colloid Analysis
CHEM 509	Physical Methods of Characterization		

Graduate Certificate Program in Materials Chemistry

The following three Graduate Certificate Programs are available:

Synthesis and Characterization of Inorganic Materials Synthesis and Characterization of Organic Materials Characterization of Inorganic and Organic Materials

To earn a certificate in materials chemistry a minimum of 12 credit hours of course work from the following two groups of courses is required. At least one course must be chosen from Group A and at least one course must be chosen from Group B. The remaining credit hours may be chosen from either group, depending upon the certificate program. Each of these courses, if completed with a B or higher, may be later applied toward the Master of Chemistry in Materials Chemistry degree if you apply and are accepted to the degree program.

Group A:

CHEM 505	Spectroscopic Methods I
CHEM 509	Physical Methods and Characterization
CHEM 542	Polymer Characterization and Analysis
Group B:	
CHEM 521	Structural Inorganic and Materials
	Chemistry
CHEM 522	Efficient Chemical and Materials Synthesis
CHEM 530	Organic Reactions and Mechanisms
CHEM 531	Tactics in Organic Synthesis
CHEM 535	Polymer Synthesis

Course Descriptions

Biology

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. (0-3-2)

BIOL 503

Virology

This course will cover topics related to animal viruses including the life cycles of major viral classes, viral pathogenesis, emergence, and control. Recent advances in these areas will be discussed in conjunction with readings from the original literature.

Prerequisite(s): [(BIOL 445) OR (BIOL 515)] (3-0-3)

BIOL 504

Biochemistry Lecture

Molecules of biological significance; reaction thermodynamics and kinetics; metabolism; cellular localization of biochemical function; proteins; nucleic acids; transcription; translation. (4-0-4)

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. (2-0-2)

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)] (3-0-3)

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.

 $\label{eq:prerequisite(s): [(BIOL 401) OR (BIOL 430) OR (CHEM 237)]}$

(3-0-3)

BIOL 515

Molecular Biology

A survey of topics including structure of nucleic acids, translation, transcription, replication, organization of DNA, RNA processing, genomics, and control of gene expression. Prerequisite(s): [(BIOL 401)]

(3-0-3)

BIOL 520

Laboratory Rotation

Independent study in the research laboratory of a faculty member. (0-9-3)

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. (1-6-3)

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. (0-1-3)

BIOL 524

Science & Law: An Introduction to Intellectual Property Law & 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. (0-1-2)

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.

(3-0-3)

BIOL 527

Immunology & Immunochemistry

Basic concepts of immunology, immunochemistry, both biological and molecular.

Prerequisite(s): [(BIOL 401)] (3-0-3)

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)] (0-9-3)

BIOL 542

Advance Microbiology Lectures

This course surveys a variety of topics regarding the biology of microbes. These include cell structure, metabolism, physiology, strategies for obtaining energy, and how this relates to microbial ecology, genetics, and comparative genomics. (3-0-3)

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.

(3-0-3)

BIOL 545

Advanced Cell Biology Lectures

This course is a continuation of BIOL 544 and focuses on recent advances in the area of cell biology. The course covers, in depth, eukaryotic cellular processes, structure-function relationships, and cellular signaling networks in response to physiological and pathological stimuli. The course will also cover frontier topics in the area of cell biology. Emphasis will be on experimental approaches. Instructor permission required.

Prerequisite(s): [(BIOL 445 and BIOL 446) OR (BIOL 533 and BIOL 544)] (3-0-3)

BIOL 550

Bioinformatics & Biotechnology

This course will present an historical introduction to bioinformatics as a driving force for biotechnological advances. Topics covered will include; collecting and storing sequences in the lab; alignment of pairs of sequences; multiple sequence alignment; phylogenetic prediction; database searching for similar sequences; gene prediction; protein classification and structure prediction; and genome analysis. (3-0-3)

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. (3-0-3)

BIOL 562

Current Topics in Functional Genomics

This course is designed to give students a foundation in advanced theoretical and applied methods in modern molecular research. It will emphasize both established and novel approaches to solving problems of functional and comparative genomics, and systems biology. It will also focus on applications of advanced molecular techniques in areas of significant economic and biomedical importance. Prerequisite(s): [(BIOL 515)]

(3-0-3)

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.

(0-0-3)

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. (0-0-3)

BIOL 576

Literature in Cell & 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. (0-0-3)

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. (0-0-3)

BIOL 584

Graduate Seminar in Biology

To foster scientific communication skills, students are required to present seminars based on the scientific literature. (1-0-1)

BIOL 591

Research & 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. (1-0-1)

BIOL 597

Special Problems Special problems in biology. Instructor permission required. (Credit: Variable)

BIOL 600

Continuation of Residence Continuation of residence. (0-0-1)

BIOL 691

Research & Thesis PHD Research and Thesis for Ph. D. students. (Credit: Variable)

Undergraduate Courses available to Graduate Students

Note: Students may take up to an approved number of the following courses.

BIOL 401 Introductory Biochemistry

BIOL 402 Metabolic Biochemistry

BIOL 410 Medical Microbiology

BIOL 414

Genetics for Engineering Scientists

BIOL 426 **Concepts of Cancer Biology**

BIOL 430 Animal Physiology

BIOL 445 Cell Biology

PHYS 410 Molecular Biophysics

Chemistry

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. (3-0-3)

CHEM 502

Gas Chromatography, Gas Chromatography Mass Spectrometry

Theory and practice of gas chromatography with emphasis in capillary gas chromatography and gas chromatography mass spectrometry.

(2-0-2)

CHEM 504

Electroanalytical Chemistry

Fundamentals including pulse and differential pulse techniques, electro-chemical detection for chromatography, flow injection analysis and remote chemical sensors. (2-0-2)

CHEM 505

Spectroscopic Methods

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. (3-0-3)

CHEM 506

Sampling & 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. (3-0-3)

CHEM 508

Analytical Methods Development

A seminar course presenting analytical methods in complex matrices with emphasis on methods development and validation. (2-0-2)

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.

(3-0-3)

CHEM 510

Electronics & Interfacing

Elementary circuit analysis, operational amplifiers, digital electronics, signal processing and interfacing of instruments using modern computer software and hardware. (2-0-2)

CHEM 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. (2-0-2)

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. (2-0-2)

CHEM 513

Statistics for Analytical Chemists

A survey providing sufficient statistical background for scientists. The topics covered include probability, statistics, sampling estimation, regression analysis, experimental design, data analysis and signal enhancement. (3-0-3)

CHEM 515

Gas Chromatography – Theory & 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. (3-0-3)

CHEM 516

Liquid Chromatography – Theory & 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 instrumentation, optimization of LC chromatography, separation, quantitative techniques, and the diverse range of analytical applications amenable to LC analysis. Prerequisite(s): [(CHEM 515)]

(3-0-3)

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. (3-0-3)

CHEM 521

Structural Inorganic & Materials Chemistry

This course covers structure and bonding and structureproperty 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. (3-0-3)

CHEM 522

Efficient Chemical & Materials Synthesis

The design and development of environmentally benign chemical pathways: challenges and opportunities. High-yield and zero-waste chemical processes. Representative processes. (3-0-3)

CHEM 524

Synthesis & 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.

(2-0-2)

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)]

(3-0-3)

CHEM 531

Tactics in Organic Synthesis

A study of modern synthetic strategies used in the preparation of complex organic molecules. Synthetic planning using the disconnection approach and the selection of reagents to solve regiochemical and stereo chemical problems will be the underlying themes. Synthetic strategies to be discussed include tandem reactions, template and chelation effects, biomimetic tactics and the use of chiral terpenes, carbohydrates and amino acids in enantioselective syntheses. Target molecules will include natural products, pharmaceuticals and smart organic materials. Prerequisite(s): [(CHEM 530)]

(3-0-3)

CHEM 535

Polymer Synthesis

In-depth study of polymer synthesis, kinetics of polymerization, solution and thermal properties, processing and characterization techniques and rheological behavior. Selected topics include high-performance polymers, conducting polymers, electro optical polymers, water-soluble polymers, biopolymers, medicinal polymers, photosensitive polymers and liquid crystalline polymers.

Prerequisite(s): [(CHEM 239)] (3-0-3)

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)] (1-6-3)

CHEM 538

Physical Biochemistry

The principles and techniques of physical chemistry applied to proteins, nucleic acids, polysaccharides and lipids. Prerequisite(s): [(CHEM 239 and CHEM 344)] (3-0-3)

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)] (3-0-3)

CHEM 542

Polymer Characterization & Analysis

This course will provide an overview of the common techniques for polymer characterization, studying structureproperty 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. (3-0-3)

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. (2-0-2)

CHEM 544

Colloids & 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. (2-0-2)

CHEM 548

Electrochemical Methods

Thermodynamics and potential, charge-transfer kinetics and mass transfer. Potential step and potential sweep methods, including hydrodynamic methods. Bulk electrolysis methods. Electrode reactions coupled with homogeneous chemical reactions. Double-layer structure and absorbed intermediates in electrode processes. Digital simulation of electrochemical processes. Students are expected to have some background in the physical chemistry of solutions and electroanalytical chemistry at the level of CHEM 500. (3-0-3)

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)] (3-0-3)

CHEM 552

Chemical Kinetics

Types of reactions, reaction order, activation energy, transition states, isotope effects and the mechanism of reactions. Determination of the rates of free radical reactions. Primary processes in thermal, photochemical and other radiation-induced reactions.

Prerequisite(s): [(CHEM 550 and CHEM 553)] (3-0-3)

CHEM 553

Introduction to Chemical Thermodynamics

Fundamental laws of thermodynamics; application to simple chemical systems. Prerequisite(s): [(CHEM 344)]

(3-0-3)

CHEM 560

Advanced Chemistry Projects

Advanced chemistry projects to be carried out under the direction of a faculty member. These projects may involve computational, theoretical, experimental work or a combination of these. Projects based on experimental work may be carried out in the research lab of the instructor. Topics of the advanced projects will be selected by the faculty member offering the course and will not necessarily be related to the dissertation topic of the student. May be taken more than once and up to 12 credit hours. (Credit: Variable)

CHEM 584

Graduate Seminar in Chemistry

To foster scientific communications skills, students are required to present seminars based on the scientific literature. Required of all first year M.S. and PhD students. (1-0-1)

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. (1-0-1)

CHEM 591

Research & Thesis (Credit: Variable)

(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 & 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 Teachers-HS

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

Continuation of residence. (0-0-1)

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. (2-0-2)

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. (2-0-2)

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. (2-0-2)

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. (2-0-2)

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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)] (2-0-2)

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)]

(2-0-2)

CHEM 635

Heterocyclic Chemistry

Of the vast array of structures which organic compounds adopt, many contain ring systems as a component. When the ring is made up of carbon and at least one other element, the compound is classified as a heterocycle. The aims of this course are to identify the effects that the presence of such ring systems have on the chemistry of a molecule; to show how the rings can be made, and to describe some of the uses of the compounds in organic synthesis, in medicine and in other contexts. The chemistry of aromatic five-, six- and seven-membered ring compounds with one or more nitrogen, oxygen and/or sulfur atoms will be emphasized. Prerequisite(s): [(CHEM 239 and CHEM 455)] (3-0-3)

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. (2-0-2)

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.

(2-0-2)

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.

(1-0-1)

CHEM 685

Chemistry Colloquium Lectures by invited scientists in areas of chemistry generally

not covered in the department. Prerequisite(s): [(CHEM 585)] (1-0-1)

CHEM 691

Research & Thesis Ph.D.

(Credit: Variable) Instructor permission required. (Credit: Variable)

Undergraduate Courses Available to Graduate Students

Note: Students may take up to an approved number of the following courses.

CHEM 415 Inorganic Chemistry

CHEM 416 Advanced Chemistry Laboratory

CHEM 451 Modern Techniques in Chemical Literature

CHEM 454 Chemical Modeling and Simulation

CHEM 455 Advanced Organic Chemistry

CHEM 470 Introduction to Polymers

Department of Biomedical Engineering

Wishnick Hall 3255 S. Dearborn Chicago, IL 60616 312.567.5100 312.567.5770 (fax) www.iit.edu/~biomed

Chair: David Mogul

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

graduate program: Biological and Chemical Sciences; Physics; Chemical and Biological Engineering; Computer Science; Electrical and Computer Engineering; Mechanical, Materials, and Aerospace Engineering; the College of Psychology; and the Center for Ethics in the Professions.

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

Degree Offered

Doctor of Philosophy in Biomedical Engineering

Research Areas

Cell and Tissue Engineering Medical Imaging Neural Engineering

Faculty

Arfanakis, Konstantinos, Associate Professor and Director of the MRI Program in the Pritzker Institute. B.S., University of Athens (Greece); M.S., Ph.D., University of Wisconsin-Madison. Magnetic resonance imaging (MRI), MRI acquisition and post-processing, diffusion tensor MRI (DTI), functional MRI (fMRI).

Arzbaecher, Robert, Emeritus Professor. Ph.D., University of Illinois, Urbana-Champaign. Instrumentation, signal processing and control.

Brey, Eric M., Associate Professor. B.S., M.Eng., University of Louisville; Ph.D., Rice University. Angiogenesis, biomaterials, tissue engineering.

Cinar, Ali, Professor of Chemical Engineering and Biomedical Engineering, Vice Provost for Research, Dean of the Graduate College, and Director of Engineering Center for Diabetes Research and Education. B.S., Robert College (Turkey); M.S., Ph.D., Texas A & M University. Agent-based systems for process modeling, supervision, and control; modeling of angiogenesis and tissue growth; diabetes and control of insulin pumbs; supervision and control of biological and chemical processes, complexity, AI applications, modeling and simulation of biomedical systems.

Demou, Zoe, Research Assistant Professor. Diploma in Chemical Engineering, Aristotle University of Thessaloniki (Greece); Ph.D., Rice University. Extracellular matrix mechanostructure in cancer cell motility and metastic potential. DePaola, Natacha, Professor and the Carol and Ed Kaplan Armour Dean of Engineering. B.S., Simon Bolivar University (Venezuela); M.S., Massachusetts Institute of Technology; Ph.D., Harvard Medical School - Massachusetts Institute of Technology.

Haferkamp, Bonnie, Senior Lecturer. B.S., Iowa State University; M.S., Ph.D., Illinois Institute of Technology.

Irving, Thomas C., Professor of Biology, Physics, and Biomedical Engineering and Executive Associate Chair -Biology, Biological and Chemical Sciences. B.Sc., M.Sc., Ph.D., University of Guelph (Canada). Structure and biophysics of macromolecular systems, muscle structure and physiology, synchrotron radiation instrumentation. Biochemistry, Molecular Biochemistry, and Biophysics.

Kamper, Derek, Associate Professor. B.S., Dartmouth College; M.S., Ph.D., Ohio State University. Neural control, biomechanics and rehabilitative medicine.

Kang-Mieler, Jennifer J., Associate Professor. B.S., M.S., Ph.D., Northwestern University. Models of thrombotic retinal vessel occlusion, blood flow, electroretinography.

Mogul, David, Associate Professor and Interim Chair. B.S., Cornell University; M.S, M.B.A., Ph.D., Northwestern University. Control of epilepsy, brain electrophysiology, brain stimulation, traumatic brain injury. Papavasiliou, Georgia, Assistant Professor. B.S., Ph.D., Illinois Institute of Technology. Computational modeling of polymerization systems, design of polymeric biomaterials for tissue engineering and drug delivery applications.

Trommer, Barbara L., Research Professor. B.A., Queens College; M.D., Columbia College, College of Physicians and Surgeons. Epilepsy, autism, and treatment for neurological disorders.

Troyk, Philip R., Associate Professor and Associate Dean, Armour College of Engineering. B.S., University of Illinois, Urbana-Champaign; M.S., Ph.D., University of Illinois-Chicago. Neural prostheses, medical device implants, neuroscience.

Turitto, Vincent, Pritzker Professor and Director of the Pritzker Institute of Biomedical Science and Engineering. B.ChE., Manhattan College; D.Engr.Sci., Columbia University. Blood flow and thrombosis, atherosclerosis, cellular biodynamics, biomaterials.

Admission Requirements

Minimum cumulative undergraduate GPA: 3.2/4.0 GRE minimum scores: 1800 (combined) 1200 (quantitative + verbal) 3.0 (analytical writing)

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

Doctor of Philosophy in Biomedical Engineering

Total Credit Hours 84

Qualifying examination (written and oral) Thesis research proposal/comprehensive examination Dissertation and oral defense

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, an industrial, or an academic environment.

A minimum of 84 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.

Biomedical Engineering Courses

- BME 500 Introduction to Biomedical Engineering
- BME 501 Biomedical Instrumentation
- BME 502 Computational Neuroscience I: Single Neuron Computation
- BME 503 Mathematics and Statistics for Neuroscience I
- BME 504 Neuroethology
- BME 505 Mathematics and Statistics for Neuroscience II
- BME 506 Computational Neuroscience II: Vision
- BME 507 Cognitive Neuroscience
- BME 508 Mathematics and Statistics for Neuroscience $$\rm III$$
- BME 509 Vertebrate Neural Systems
- BME 518 Advanced Reaction Kinetics
- BME 521 Medical Imaging
- BME 522 Mathematical Methods in BME
- BME 523 Cell Biomechanics
- BME 524 Qualitative Aspects of Cell and Tissue Engineering
- BME 525 Concepts of Tissue Engineering
- BME 530 Inverse Problems in Biomedical Imaging
- BME 532 Medical Imaging Science
- BME 533 Biostatistics
- BME 535 Magnetic Resonance Imgaing
- BME 538 Neuroimaging
- BME 540 Wave Physics and Applied Optics for Imaging Scientists
- BME 542 Advanced Concepts in Image Science
- BME 543 Bioinstrumentation and Electronics
- BME 551 Physiological Signal Analysis & Control Theory I
- BME 552 Physiological Signal Analysis & Control Theory II
- BME 553 Quantitative Physiology
- BME 570 Engineering Biocompatible Materials
- BME 575 Neuromechanics of Human Movement
- BME 581 Fluid Dynamics for Biomedical Engineers
- BME 582 Advanced Mass Transport for Biomedical Engineers
- BME 585 Computational Models of the Human Cardiovascular System
- BME 595 Seminar in Biomedical Engineering
- BME 597 Special Problems
- BME 691 Research and Thesis for Ph.D. degree

Selected Engineering Electives

Doctor of Philosophy in Biomedical Engineering - continued

Life Science Courses (representative)

- BIOL 403 General BiochemistryBIOL 414 Genetics for Engineering ScientistsBIOL 430 Animal PhysiologyBIOL 445 Cell BiologyBIOL 513 Advanced Biochemistry
- BIOL 515 Molecular Biology
- BIOL 527 Immunology and Immunochemistry $% \left({{{\rm{BIOL}}}} \right)$
- BIOL 550 Bioinfomatics and Biotechnology
- BIOL 565 Vertebrate Physiology

Approved Math/Applied Math Courses

MATH 461	Fourier Series and Boundary-Value Problems
MATH 471	Numerical Methods I
MATH 472	Numerical Methods II
MATH 476	Statistics
MATH 489	Partial Differential Equations
MATH 510	Ordinary Differential Equations
MATH 512	Partial Differential Equations
MATH 519	Complex Analysis
MATH 532	Linear Algebra
MATH 542	Stochastic Processes
MATH 546	Introduction to Time Series
MATH 555	Tensor Analysis
MATH 564	Applied Statistics
MATH 577	Computational Mathematics I

- MATH 578 Computational Mathematics II
- MATH 581 Theory of Finite Elements

Engineering or Physics Courses (representative) (may count toward math requirement)

- CHE 535 Applications of Mathematics to Chemical Engineering
- CHE 536 Computational Techniques in Engineering
- MMAE 501 Engineering Analysis 1b $\,$
- MMAE 502 Engineering Analysis II
- MMAE 503 Advanced Engineering Analysis
- MMAE 505 $\,$ Numerical Methods in Engineering
- MMAE 506 Computational Methods in Engineering Analysis
- MMAE 517 Computational Fluid Mechanics
- PHYS 501 Methods of Theoretical Physics I
- PHYS 502 Methods of Theoretical Physics II

CHE 450	Principles of Polymer Science and Engineering
CHE 532	Process Modeling
CHE 533	Statistical Analysis of Process Data
CHE 544	Kinetic Theory of Multiphase Flow
CHE 555	Polymer Processing
CHE 573	Bioseparations
CHE 575	Polymer Rheology
CHE 586	Particulate Technology
CHE 761	Statistical Design of Experiments for Process
	Improvement
CHE 577	Biochemical Engineering
CHE 579	Enzyme Reactor Engineering
CHE 582	Interfacial and Colloidal Phenomena with
	Applications
CHE 583	Pharmaceutical Engineering
CHE 585	Drug Delivery
CS 480 A	rtificial Intelligence
CS 525 A	dvanced Database Organization
CS 580 M	fedical Informatics
CS 583 E	xpert Systems
ECE 433	Real-Time Data Acquisition and Processing
ECE 511	Analysis of Random Signals
ECE 565	Multidimensional Signal Processing
ECE 566	Statistical Pattern Recognition
ECE 567	Statistical Signal Processing
MMAE 40	7 Biomechanics
MMAE 46	7 Polymeric Materials
MMAE 50	7 Introduction to Continuum Mechanics
MMAE 51	0 Fluid Mechanics
MMAE 51	2 Dynamics of Viscous Fluids
MMAE 51	7 Computational Fluid Dynamics

MMAE 579 Characterization of Polymers

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. (3-0-3)

BME 501

Biomedical Instrumentation

Bioelectric phenomena, transducers, amplifiers. Processing of ECG. EMG. EEG (3-0-3)

BME 503

Mathematical & 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.

(2-0-2)

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. (2-0-2)

BME 505

Mathematical & Statistical Methods for Neuroscience III

This guarter 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)] (2-0-2)

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. (3-0-3)

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. (2-0-2)

BME 508

Math/Statistics: Neuroscience III

This course covers more advanced topics including perturbation and bifurcation methods for the study of dynamical systems, symmetry methods, and some group theory. A variety of applications to neuroscience with be described. Instructor permission required.

Prerequisite(s): [(BME 503 and BME 505)]

(2-0-2)

BME 509

Vertebrate Neural Systems

This lab-centered course teaches students the fundamental principles of mammation neuroanatomy. Students learn the major structures and the basic circuitry of the CNS and PNS. Students become practiced at recognizing the nuclear organization and cellular architecture of many regions in animal brain models. This course is taught at the University of Chicago. Instructor permission required. (3-0-3)

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. (2-0-2)

BME 511

Extracellular Matrices: Chemistry & Biology

Advanced topics dealing with the biology and chemistry of the extracellular matrix, cell-matrix interactions, and current methodologies for engineering these interfaces. (2-0-2)

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. (2-0-2)

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.

(3-0-3)

BME 518

Reaction Kinetics for Biomedical Engineering

This course is an introduction to the fundamentals of chemical kinetics. Analysis of rate data; single and multiple reaction schemes. Biomedical topics include biological systems, enzymatic pathways, enzyme and receptor-ligand kinetics, pharmacokinetics, heterogeneous reactions, microbial cell growth and product formation, and the design and analysis of biological reactors.

Corequisite(s): (BME 482)

Prerequisite(s): [(BME 301, BME 335, and MATH 252)] (3-0-3)

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. (3-0-3)

(0-0-0)

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. (3-0-3)

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. Open only to Biomedical Engineering majors.

(3-0-3)

BME 523

Cell Biomechanics: Principles & 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. (3-0-3)

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. (3-0-3)

BME 525

Concepts of Tissue Engineering

This course seeks to provide students with an introduction to the field of Tissue Engineering. The first portion of the course will introduce the field, including a discussion of cell sourcing, biomaterials, DA, and ethical considerations. The second portion of the course will present case studies in specific tissue and organ systems in which these concepts are put together in an attempt to develop a clinically applicable tissue engineered product. (3-0-3)

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. (3-0-3)

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. (3-0-3)

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. (3-0-3)

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. (3-0-3)

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. (3-0-3)

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. (3-0-3)

BME 540

Wave Physics & 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. (3-0-3)

BME 542

Advanced Concepts in Image Science

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

BME 543

Bioinstrumentation & Electroncis

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. (3-0-3)

BME 551

Physiological Signal Processing & 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. (2-0-2)

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.

(3-0-3)

BME 553 Quantitative Physiology

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

Prerequisite(s): [(BIOL 430)]

(3-0-3) BME 570

Engineering Biocompatible Materials

The primary objective of this course is to introduce students to synthetic materials that are routinely used as components of various medical devices implanted in the human body. In this course, students will critically examine prosthetic materials used in specific devices (for example: muscle, eye, skin, vascular). The biological environment relevant to the discussed implant will be reviewed. Problems with current materials will be analyzed and strategies and techniques required to engineer sophisticated biomaterials for future applications will be developed. Legal procedures required to obtain FDA approval for such materials will be taught. Industry personnel specializing in medical implants will deliver guest lectures. Instructor permission required. (3-0-3)

BME 575

Neuromechanics of Human Movement

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

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)] (3-0-3)

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.

(3-0-3)

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 (3-0-3)

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. (3-0-3)

BME 597

Special Problems Special problems. (Credit: Variable)

BME 691

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

Stuart School of Business

10 West 35th Street, 18th Floor Chicago, IL, 60616

565 W. Adams St., Fourth Floor Chicago, IL 60661

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Dean: Harvey Kahalas

Program Contacts:

Master of Business Administration: Krishna Erramilli Environmental Management and Sustainability: Krishna Erramilli

Finance: John Bilson

Marketing Analytics and Communications: Krishna Erramilli

Master of Public Administration: Richard Bonaccorsi

Masters in Mathematical Finance: Tomasz Bielecki

Ph.D. in Management Science: Siva K. Balasubramanian

Business at IIT

IIT Stuart School of Business provides intellectually rigorous business and management education at all levels, from baccalaureate to doctoral. All IIT Stuart programs are designed to educate tomorrow's global innovators through the unique concept of strategic competitiveness. Constructs including creativity, innovation, entrepreneurship, incisive decision-making, leadership, and sustainability are interwoven throughout coursework and professional development opportunities, offering students thorough preparation for the challenges of the Next Economy.

Established in 1969 with a gift from IIT alumnus and Chicago financier Harold Leonard Stuart, IIT Stuart offers a wide range of challenging business and management programs taught from a practical perspective, with an emphasis on analytic skills and the relation between business, management, and technology. AACSBaccredited programs include the M.B.A., Ph.D., five industry-responsive master's programs, and one bachelor of science in business program. IIT Stuart also offers a Master of Public Administration (M.P.A.) degree.

Stuart faculty, in addition to their scholarly and teaching activities, are consultants to major national and international corporations. Their expertise has been called upon

Degrees Offered

Master of Business Administration (MBA)

- Masters in Mathematical Finance (collaborative program with IIT's Department of Applied Mathematics)
- Master of Science in Environmental Management and Sustainability
- Master of Science in Finance
- Master of Public Administration
- Master of Science in Marketing Analytics and Communications
- Doctor of Philosophy in Management Science

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 IIT Stuart students are also working professionals from Chicago's preeminent business, public, and finance communities.

Student resources include a Career Management Center with services available to current students and alumni; an Office of Student Services; the Stuart Business Library; and state-of-the-art technological resources, including more than 100 student workstations, interactive computer labs featuring the latest industry software, and a fully wireless campus. In addition, faculty and students at the Stuart School can access the WRDS database, which contains over 200 terabytes of data covering multiple disciplines, including marketing, economics, and finance.

IIT Stuart operates on a semester academic calendar consisting of two semesters beginning in August and January and a summer session beginning in May. Because many Stuart students work full time, all graduate classes are regularly offered as weekday evening or weekend classes. Courses are also offered in the day-time.

Dual Degree Programs

M.B.A./M.S. in Environmental Management and Sustainability M.B.A./M.S. in Marketing Analytics and Communication M.B.A./M.S. in Finance M.B.A./Master of Public Administration

Graduate Certificate Programs

Business Administration

Business Analyst Corporate Finance Entrepreneurial Finance Financial Economics Financial Modeling Financial Toolbox Fundamentals of Finance Innovation and Emerging Enterprises Investments Marketing Management Risk Management Trading

With the Institute of Design M.Des/M.B.A.

With the IIT Chicago-Kent College of Law J.D./M.B.A.

J.D./M.S. in Environmental Management and Sustainability J.D./M.S. in Finance J.D./Master of Public Administration

Public Administration

Nonprofit and Mission-Driven Management Public Management Security, Safety, and Risk Management

Research Facilities

The campus libraries are an open-stack collection of more than 525,000 volumes, including the holdings of the Stuart Business Library, the Chicago-Kent Law Library, and the Library of International Relations, which contains international materials in history, economics, political science, and law. IIT Stuart's facility is equipped with computer labs, offering more than 100 student workstations linked to the Internet and networked with IIT libraries. The computer labs offer access to a wide range of business software and resources. A Quantitative Research Lab provides an interactive learning environment, featuring simulated trading, investment analysis, and financial industry databases.

The **Center for Financial Markets** provides a unique focus on four interrelated spheres of knowledge needed by any professional who works for a financial intermediary or other capital market institution: financial markets, trading, financial engineering, and information technology. The Center supports Stuart's M.S. in Finance program and promotes scholarship and linkages to Chicago's financial industry, and assists faculty and students to contribute actively to projects in electronic trading, risk management, and new derivative products development. Michael Gorham, director, can be reached at 312.906.6520 or gorham@stuart.iit.edu. The **Center for Strategic Competitiveness** (CSC) is the nerve center for research and outreach activities of the Stuart School of Business, developing global partnerships to enhance innovation and creativity, and providing quality, high level executive education customized to meet discipline-specific demands. Our mission is to develop Strategic Competitiveness into an approach to business that enhances the ability of individuals, organizations, and governmental units to respond proactively, innovatively and exceptionally to global market challenges in today's and tomorrow's economy.

The CSC provides a cross-discipline approach to competitiveness, combining psychology (decision making and leadership), design (creativity, innovation, and entrepreneurship), and engineering (sustainability). Our research and program efforts are developed within a network of partnerships, bringing together the knowledge and experience of executives, lawmakers, academics and experts in an array of fields. The CSC is tasked with the responsibility of making certain that the heart of the Stuart School of Business Strategic Competitiveness is always evolving and adapting to the present and future demands of global business. We do this, in part, through a major portfolio of research, symposia, public information, and public awareness of competitiveness issues developed in partnership with a variety of funders. Director Harvey Kahalas can be reached at 312.906.6500 or csc@stuart.iit.edu

Faculty

Anand, Smriti, Assistant Professor of Management. B.S., Ranchi University (India); M.B.A., Northwestern University; M.S., Ph.D., University of Illinois-Chicago.

Ashton, Weslynne, Assistant Professor of Environmental Management and Sustainability. B.S., Massachusetts Institute of Technology; Master of Environmental Science, Ph.D., Yale University.

Balasubramanian, Siva K., Harold L. Stuart Professor of Marketing, Associate Dean, and Co-Director, Ph.D. Program. B.S., M.B.A., Osmania University; Ph.D., State University of New York at Buffalo. Managing innovations/new product diffusion, marketing communications and research methods, social media marketing.

Bariff, Martin L., Associate Professor of Information Management. B.S., M.A.S., Ph.D., University of Illinois, Urbana-Champaign. Impact of information technology on business strategy, organizational structure, management controls and human decision-making.

Bilson, John, Professor of Finance, Interim Associate Dean, and Director of Master's of Finance Program. B.Econ, M.Econ, Monash University-Melbourne, Australia; Ph.D., University of Chicago. International finance, quantitative investment strategies.

Bonaccorsi, Richard, Senior Lecturer of Public Administration and Director of the M.P.A. Program. B.A., DePauw University; Master of International Management, Thunderbird University; Ph.D., Case Western Reserve University.

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Cai, Li, Assistant Professor of Finance. B.S., Wuhan University (China); M.Sc., Warwick Business School (England); Ph.D., University of Massachusetts.

Calia, Roland, Senior Lecturer of Public Administration. B.A., University of Redlands; M.A., Claremont Graduate School; Ph.D., University of Chicago.

Chakravarti, Arjun, Assistant Professor of Management. B.A., University of Colorado; M.B.A., Ph.D., University of Chicago.

Chaudoin, Gregory S., Instructor of Finance. B.S. University of Louisville; M.S., University of Illinois, Urbana-Champaign. Portfolio theory and risk analysis and management.

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Cooper, Tina K., Senior Lecturer and Assistant Dean. B.F.A., Syracuse University; M.A., University at Albany-SUNY; M.B.A., DePaul University. Durango-Cohen, Elizabeth, Assistant Professor of Operations Management. B.S., Sonoma State University; M.S., Ph.D., University of California, Berkeley. Supply chain management, supply chains, inventory and production planning, and capacity and pricing.

Ehrlich, David G., Clinical Assistant Professor of Business. M.A., University of Michigan; M.P.P., Georgetown University; Ph.D., Wayne State University.

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Geisler, Eliezer, Distinguished Professor of Organizational Behavior. B.A., M.B.A., Tel Aviv University (Israel); Ph.D., Northwestern University. Organizational behavior, health care technology management, management of information and telecommunication technology, strategic management.

Goldhar, Joel D., Professor of Operations and Technology Management. B.Ch.E., Rensselaer Polytechnic Institute; M.B.A., Harvard University; D.B.A., George Washington University. Computer-integrated manufacturing, the impact of technology on business strategy.

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Hamilton, Charles T., Clinical Associate Professor of Accounting. B.S., M.A.S., Ph.D., University of Illinois, Urbana-Champaign; Certified Public Accountant. Accounting education, the behavioral factors that influence audit judgment.

Hassan, M. Zia, Professor of Management Science, Dean Emeritus, and Co-Director, Ph.D. Program. B.Sc., University of Punjab (Pakistan); M.S., Ph.D., Illinois Institute of Technology. Effective organizations, strategic and quality issues in organizations.

Kahalas, Harvey, Harold L. Stuart Professor of Management and Economic Development, and Dean of Stuart School of Business. B.S., Boston University; M.B.A., University of Michigan; Ph.D., University of Massachusetts. Economic development, organizational competitiveness.

Kang, Sang Baum, Assistant Professor of Finance. B.A., Yonsei University (Korea); M.S., University of Wisconsin; M.S., Carnegie Mellon University; Ph.D., McGill University. Khalili, Nasrin R., Associate Professor of Environmental Management. B.Sc., M.S.P.H., Tehran University (Iran); Ph.D., Illinois Institute of Technology. Atmospheric chemistry, environmental impact analysis, environmental system analysis, and waste engineering.

Liao, Jianwen, Associate Professor of Entrepreneurship. B.S., Northeast University (China); M.B.A., People's (Renmin) University of China; Ph.D., Southern Illinois University-Carbondale. Entrepreneurial dynamics, venture formation, technology innovation and business planning.

McWilliams, Abagail, Visiting Professor of Management and Associate Dean. B.S., M.A., Ph.D., The Ohio State University.

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Peters, Scott, Senior lecturer of Public Administration. B.A., Macalester College; J.D., Washington University; Ph.D., University of Illinois-Chicago.

Ramanan, Ram, Associate Industry Professor of Environmental Management. B.Tech., Indian Institute of Technology; M.S., UICT, Bombay University (India); M.B.A., University of Texas-Austin; Ph.D., University of Texas-Dallas.

Richardson, David W., Assistant Professor of Entrepreneurship. B.A., Rice University; Ph.D., University of Texas-Dallas.

Rybak, Michael J., Senior Lecturer of Finance. B.S., Illinois State University; M.B.A., DePaul University.

Sabbaghi, Navid, Assistant Professor of Management Science. B.A., B.S., University of California-Berkeley; M.S., Ph.D., Massachusetts Institute of Technology. Supply Contracts and capacity pricing in supply chain management. Sun, Jiong, Assistant Professor of Management. B.Sc., Shanghai Jiao Tong University; M.Eng., National University of Singapore; M.S., Ph.D., Carnegie Mellon University. The interaction of technology, firms, markets, and the environment.

Tourk, Khairy A., Professor of Economics/International Business. B.S., University of Alexandria (Egypt); M.A., Vanderbilt University; Ph.D., University of California-Berkeley. Evolution of the Asian enterprise, economics of the newly industrializing Asia.

Twombly, John R., Clinical Professor of Accounting and Finance and Director of Undergraduate Programs. B.S., University of Pennsylvania; M.B.A., Ph.D., University of Chicago; Certified Public Accountant. Financial and managerial accounting.

Van Vliet, Benjamin, Assistant Professor of Finance. B.A., Calvin College; M.S., Ph.D., Illinois Institute of Technology.

Wagman, Liad, Assistant Professor of Economics. B.A., B.S., University of North Carolina; M.S., Stanford University; M.A., Ph.D., Duke University.

Wang, Haizhi, Assistant Professor of Finance. B.S., Wuhan University (China); M.S., East China Normal University (China); Ph.D., Rensselaer Polytechnic Institute. Corporate Finance, financial institutions, entrepreneurial finance, mergers and acquisition, strategic alliances.

Weiss, Suzanne, Senior Lecturer of Business. B.A., University of Rochester; M.B.A., University of Chicago. Strategic marketing, marketing research, and new product development.

Wu, Tao, Assistant Professor of Finance. B.A., Columbia University; Ph.D., Wharton School. Asset pricing, investments, derivatives, fixed-income, international/ corporate finance.

Graduate Programs

All graduate programs in business are subject to continuous improvements. Prospective students are urged to refer to the Stuart website, http://www.stuart.iit.edu/,

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) scores of at least 600 (250 computer), unless they received an undergraduate or graduate degree from an accredited U.S. institution. English language proficiency assessment is required of all international stuents. Assessment results will determine which, if any, for the most current description of all programs and degree requirements.

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 and IELTS.

Applicants to the Ph.D. program in management science must have completed a masters degree with a graduate level business core, or a Masters in Finance or equivalent degree. For applicants who have a masters degree but have not completed the business core, some prerequisite courses will be required.

Master of Business Administration (M.B.A.)

The Master of Business Administration requires the succesful 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 a year-and-a-half by taking more courses each semester and attending school during the summers - but this requires careful planning.

Core Courses

- BUS 510 Building an Innovative and Sustainable Business
- BUS 550 Busines Analytics for Competitive Advantage
- BUS 590 Business Innovation in the Next Economy (Integrated Capstone Course)
- MBA 501 Financial and Managerial Accounting
- MBA 502 Emerging Issues in the Global Business Environment
- MBA 504 Spreadsheet Modeling
- MBA 505 Contemporary Economic Analysis and Game Theory
- MBA 506 Leading and Managing Knowledge-Intensive Organizations
- MBA 509 Financial Management in a Globalized World
- MBA 511 Creating, Communicating, and Delivering Customer Value
- MBA 513 Operations and Technology Management

Concentrations

A concentration consists of a minimum of 6 credit hours in one of the following areas:

- Strategy and Leadership
- Business and Society
- Sustainability
- Creativity and Innovation
- Emerging Markets
- China Studies
- Technopreneurship
- Technology and Marketing
- Management of Public Sector
- Business Analytics
- Finance

Master of Science in Environmental Management and Sustainability

To earn an M.S. 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 1 and completing their program in Summer of Year 2 - but this requires careful planning.

Required Courses (full semester)

- BUS 510 Building an Innovative and Sustainable Business
- BUS 550 Busines Analytics for Competitive Advantage
- BUS 590 Business Innovation in the Next Economy (Integrated Capstone Course)
- EMS 501 Environmental Policy in a Competitive World
- EMS 502 Contemporary and Emerging Laws Governing the Environment
- EMS 503 Environmental Pollution Prevention and Control Strategies
- EMS 504 $\,$ Industrial Ecology and Systems Thinking
- EMS 505 Environmental Finance

Elective Courses

Students could take any 3 electives from the following list:

- EMS 511 Solid and Hazardous Waste Management and Remediation
- EMS 512 Environmental Risk Assessment and Management
- EMS 513 Environmental Economics and Climate Change
- EMS 518 Ethics and Corporate Social Responsibility
- EMS 525 Environmental Performance Analytics
- EMS 526 Managing Sustainable Supply Chains
- EMS 529 Social Entrepreneurship
- EMS 531 Environmental Advocacy
- EMS 532 Environmental and Energy Law Clinic
- EMS 541 Managing Environmental Technologies
- EMS 542 Economics of Energy Systems

Master of Science in Finance

The M.S. Finance program requires that participants complete a total of 11 semester courses. The typical program will consist of six core cores and five elective courses. However, students may request that they be allowed to substitute an elective course for a core course if they can demonstrate to the program director that they have already mastered the material in the core course.

Core Courses

- MSF 501 $\,$ Mathematics with Financial Applications
- MSF 502 Statistical Analysis in Financial Markets
- MSF 503 Financial Modeling
- MSF 504 Valuation and Portfolio Management
- MSF 505 Futures, Options and OTC Derivatives
- MSF 506 Financial Statement Analysis

Elective Courses

Elective classes are organized into concentrations. Students who complete one or more courses within a particular concentration will have the concentration recognized on their degree and on official transcripts.

Corporate Finance

MSF 534 Corporate Finance

MSF 535 Investment Banking

Financial Economics

MSF 564 Financial Theory

MSF 565 International Finance Theory

Financial Econometrics

- MSF 566 Financial Time Series Analysis
- MSF 567 Bayesian Econometrics

Financial Engineering

- MSF 524 Models for Derivatives
- MSF 525 Interest Rates, Term Structure and Credit Models

Financial Markets

- MSF 591 Global Financial Markets
- MSF 593 Global Investment Strategies

Financial Programming

- MSF 574 .NET and Database Management
- MSF 575 C++ with Financial Applications

High Frequency Finance

MSF 576 OOP and Algorithmic Trading Systems MSF 577 High Frequency Trading Systems

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Investment Management

MSF 545 Structured Fixed Income Portfolios MSF 546 Quantitative Investment Strategies

Risk Management

MSF 554 Market Risk Management

MSF 555 Credit Risk Management

Alternative Investments

- MSF 547 Alternative Investment Vehicles
- MSF 595 Commodities and Managed Futures

Trading

- MSF 584 Equity and Equity Derivatives Trading
- MSF 585 Fixed Income Options and Securities

Entrepreneurial Finance

MSF 594 Entrepreneurial Finance

MSF 595 The Venture Capital Process

Core Requirement

All M.S. Finance students must complete the six core classes unless they have obtained written permission from their academic advisor 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 advisor. Qualified students may substitute courses from the M.S. in Mathematical Finance for elective courses in the M.S. 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 Main Campus graduate programs, provided that: (1) they are consistent with the M.S. Finance program objectives; (2) they have been approved, prior to the student's registration, by the M.S. Finance Program Director or the student's academic advisor.

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 (i.e. FM 492) cannot be used as free electives in the M.S. Finance program.

Masters in Mathematical Finance

The Master's in Mathematical Finance is a degree offered jointly by the Stuart School of Business and the IIT Department of Applied Mathematics. Students are required to complete a total of 11 semester courses, including eight core courses and three elective courses.

Core Courses

- MSF 505 Futures, Options and OTC Derivatives
- MSF 526 Computational Finance
- MSF 575 C++ with Financial Applications
- MATH 542 Stochastic Processes
- MATH 548 Mathematical Finance I
- MATH 565 Monte Carlo Methods in Finance
- MATH 582 Mathematical Finance II
- MATH 586 Theory and Practice of Fixed Income Modeling

Elective Courses from the Department of Applied Mathematics

- CS 522 Data Mining
- MATH 512 Partial Differential Equations
- MATH 522 Mathematical Modeling
- MATH 540 Probability
- MATH 543 Introduction to Stochastic Analysis
- MATH 544 Stochastic Dynamics
- MATH 545 Stochastic Partial Differential Equations
- MATH 546 Introduction to Time Series
- MATH 566 Multivariate Analysis
- MATH 567 Advanced Design of Experiments
- MATH 569 Statistical Learning
- MATH 577 Computational Mathematics I
- MATH 578 Computational Mathematics II
- MATH 579 Complexity of Numerical Problems
- MATH 587 Theory and Practice of Modeling Credit Risk and Credit Derivatives
- MATH 589 Numerical Methods for PDEs
- MATH 590 Meshfree Methods

Elective Courses from the Stuart School

- MSF 524 Models for Derivatives
- MSF 525 Interest Rates, Term Structure and Credit Models
- MSF 545 Structured Fixed Income Portfolios
- MSF 546 Quantitative Investment Strategies
- MSF 554 Market Risk Management
- MSF 555 Credit Risk Management
- MSF 556 Enterprise Risk Management
- MSF 564 Financial Theory
- MSF 565 International Finance Theory
- MSF 566 Financial Time Series Analysis
- MSF 567 Bayesian Econometrics
- MSF 574 .NET and Database Management
- MSF 576 OOP and Algorithmic Trading Systems
- MSF 577 High Frequency Finance
- MSF 584 Equity and Equity Derivatives Trading
- MSF 585 $\,$ Fixed Income Options & Securities
- MSF 586 Advanced Options Trading

Core Requirement

All Mathematical Finance students must complete the eight core classes unless they have obtained written permission from their academic advisor 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 advisor.

Electives

At least one elective must be taken in Finance and at least one elective must be taken in Math from the elective options listed above.

Free Electives

One graduate level elective may be taken from outside the courses prescribed above, provided that it is consistent with the MMF program objectives and has been approved by the Program Director prior to the student's registration.

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 Marketing Analytics and Communication

The M.S. in Marketing Analytics and Communication (MSMAC) requires the succesful completion of of 33 credits (11 courses). Part-time students can enroll for as few as one course per semester and can take up to five years to complete their degree. Full-time students are expected to enroll for at least three courses per semester and can complete their degree in two years. The program schedule allows flexibility to students who wish to accelerate their studies. For example, full-time students could graduate in roughly a year by starting in Summer of Year 1 and completing their program in Summer Year 2 - but this requires careful planning.

Core Courses

- BUS 510 Building an Innovative and Sustainable Business
- BUS 550 Busines Analytics for Competitive Advantage
- BUS 590 Business Innovation in the Next Economy (Integrated Capstone Course)
- MAC 501 Insights into the Next Economy Markets
- MAC 502 Spreadsheet Modeling
- MAC 503 Marketing Research and Engineering
- MAC 504 Creating, Communicating, and Delivering Customer Value
- MAC 505 Strategic Marketing Management

Concentrations A concentration consists of a minimum of 9 credit hours in each of the following areas:

Marketing Analytics Concentration (take all 3 courses):

- MAC 521 Qualitative & Survey Research Methods in Business
- MAC 522 Predictive Analytics
- MAC 523 Social Media Marketing Analytics

Marketing Communication Concentration

MAC 511 Integrated Marketing Communication Strategy

AND two of the following:

- MAC 512 Customer Touch Points
- MAC 513 Managing Sustainable Brands
- MAC 514 Customer Relationship Management
- MAC 515 Database & Direct Marketing
- MAC 516 Social Media Marketing Strategy

Master of Public Administration

The IIT Stuart M.P.A. gives students the knowledge and skills they need to gain a competitive advantage throughout their careers in the fast-changing world of public and non-profit management. It combines rigorous course work with a practical orientation toward public and non-profit management and policy analysis. The program enphasizes administrative knowledge, policy formulation, human and financial resource management, strategic planning, and the development of effective implementation strategies. Courses are taught by faculty with outstanding academic credentials and extensive practice experience. Students have the opportunity to learn from and network with professionals who come from a broad range of academic backgrounds, positions, and organizations. M.P.A. students share a common goal of contributing in significant ways to their organizations and the betterment of society. Specializations are offered in: Nonprofit Mission Driven Manatement; Security, Safety and Risk Management; and Economic Development and Social Entrepreneurship.

IIT has offered educational programs in public administration since the 1940s. Building on the foundations laid by former faculty members Herbert A. Simon (a Nobel Laureate), Victor Thompson, and Donald Smithburg, the current program focuses on educating students to become effective governmental or nonprofit managers.

Master of Public Administration

The M.P.A. degree requires a minimum of 33 credit hours of graduate work. The program of study requires completion of the following 8 core courses:

Required Courses

- PA 501 Essentials for Public Management in a Complex Society: Processes, Structures and Values
- PA 502 Leading and Managing Knowledge-Intensive Organizations
- PA 509 Integrative Practicum for Effective Leadership in Public and Nonprofit Organizations
- PA 522 Effective Management of Human Resources in Environments of Scarce Resources
- PA 568 Strategic Competitiveness in the Public Sector
- PA 580 Policy Evaluation Analytics
- PA 581 Policy Design Analytics

In addition to the core courses, students choose 3 elective courses. 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 advisor and the M.P.A. Program Director. No more than six credit hours may be taken in IIT courses numbered between 400 and 499. A maximum of nine credits 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 advisor and the M.P.A. Program Director.

Master of Public Administration 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

Master of Public Administration 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 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.

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.

Master of Public Administration with Economic Development and Social Entrepreneurship Specialization

The specialization in Economic Development and Social Entrepreneurship is designed for professionals who want to become Economic Development Leaders of Social Entrepreneurs. They will become managers and entrepreneurs who drive socially responsible economic change in a rapidly changing global environment. These professionals may work in the public sector specializing in developing cutting edge economic development strategies and programs at the local, state, or federal level or they may want to be mission-driven entrepreneurs who organize, manage, or create ventures that utilize social capital to foster local or regional economic development. Students take the regular M.P.A. core curriculum and three electives from the Economic Development and Social Entrepreneurship courses offered in the program.

Master of Public Administration with Public Works Specialization

The Surart Graduate Program in Public Administration cooperates with the IIT Department of Civil, Architectural and Environmental Engineering (CAEE) in that department's offering of a Master of Public Works (MPW) degree. This program was initiated in 1982 by the Graduate Program in Public Administration in conjunction with the CAEE, the Chicago Metropolitan Chapter of the American Public Works Association (APWA), and the Education Foundation of the APWA.

CAEE students take a total of 11 courses:

Four core courses

- CAE 574 Economic Decision Analysis in Construction
- CAE 575 Systems Analysis in Construction
- PA 501 Essentials for Public Management in a Complex Society: Processes, Structures and Values (offered each semester)
- PA 551 Public Infrastructure Management (offered each spring)

 \mathbf{AND} four engineering electives

- ${\bf AND}$ two public administration electives
- **AND** one CAEE special problems

Doctor of Philosophy in Management Science

IIT Stuart offers a Ph.D. in Management Science. This program 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 acdemia (university teaching and research) 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.

Program Requirements

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 advisor. The Ph.D. committee carefully matches the interest of the student with the expertise of the faculty member. The program offers two concentrations, operations and finance.

In order to earn a Ph.D. in Management Science, students are required to complete a total of 64 credit hours beyond the master's degree, with 16 credits devoted to dissertation research work. Students are required to complete 12 courses in the first two years, including eight Ph.D. core courses and four advanced elective courses in the chosen area of concentration (Operations or Finance). In the third and fourth year of study, students enroll in four advisor-approved open electives, in addition to registering for dissertation. A qualifying exam is administered upon completion of all cousework required for the first two years of study for full time students.

Operations Concentration

Operations emphasizes the design and implementation of systems that improve the effectiveness and efficiency of organizations. Student learning focuses on effective optimization of a given firm's resources (people, technology, finance, and information) in order to secure competitive advantage. Effective Operations are critical to any firm engaged in producing products or providing services.

Finance Concentration

The Ph.D. with a finance concentration is offered only as part of the Master of Science in Finance/Ph.D. Dual Degree Program, unless the applicant has earned a graduate degree that is equivalent to the M.S.F. program at IIT Stuart, as determined by the Program Director. Students in this dual degree program may earn both an M.S. in Finance and a Ph.D. in Management Science. Graduates of the Ph.D. program with a concentration in Finance have a wide choice of careers. In addition to a traditional academic career focused on teaching and research, graduates may also work in investment and commercial banking, trading, and risk management. Dissertation research in this area may include a wide range of topics such as risk modeling, financial time series analysis, and investment analysis.

Program Structure

The IIT Stuart Ph.D. program offers two areas of concentration (Operations and Finance), and requires 64 credits to complete the program.

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.

MSC 511 Economics I MSC 512 Probability and Statistics I MSC 513 Optimization I MSC 514 Economics II MSC 515 Econometrics MSC 516 Optimization II

Qualifying Exam: This exam has a diagnostic purpose. IIT Stuart determines its form and scope. The qualifying exam may be taken only twice.

In the second year, full-time students will complete the Ph.D. advanced core and elective courses (a six course sequence consisting of two Ph.D. advanced core courses and four advanced electives as shown below) before taking the comprehensive exam.

Two Advanced Core Courses

MSC 611 Philosophy of Management MSC 612 Advanced Research Methods

Four Advanced Electives from the Following

MSC 621 Corporate Finance
MSC 622 Enterprise Risk Management
MSC 631 Theory of Finance
MSC 632 International Finance Theory
MSC 641 Operations I
MSC 642 Operations II

Doctor of Philosophy in Management Science - continued

Comprehensive Exam: After completion of 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 gradute study. The comprehensive exam may be taken only twice.

In the third and fourth year of graduate study, students will take four advisor approved elective courses (or 12 credit hours) and enroll for 16 dissertation credit hours.

Program of Study

IIT 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 yeas prior to the awarding of the degree. After completion of coursework and qualifying/comprehensive exam requirements, the dissertation research may be done off campus if suitable arrangements for supervision are made.

When a student is ready to to begin dissertation research work, the dean of the Stuart School will appoint a mutually acceptable research advisor to supervise the student's research. The chosen dissertation project must be an original investigation of high quality, and the results must be submitted in the form of a dissertation and of a related publishable manuscript. After submitting a completed dissertation, the student will appear before an oral thesis defense committee composed of at least four full-time faculty members, one of whom will be a representative from outside the student's field. There must be a period of at least one semester between the date of the comprehensive examination and the final defense.

Students may take up to six years to complete the degree. After six years, students may petition for an extension, but they must reapply to the program and may be required to retake a comprehensive examination. A cumulative GPA of 3.0/4.0 in an approved program of study is a requirement for the Ph.D. program.

Students entering the program may transfer up to two courses from a graduate program at another AACSB accredited university if the student has not used the courses to satisfy the requirements for a degree at the university. Additional courses may be transferred with the permission of the program director.

Some students may be required to take prerequisite courses in mathematics, statistics, or computer programming before being admitted to a graduate course. Undergraduate course offerings, which typically are listed with a primary numeral of four or below, cannot be used as free electives in the Ph.D. program.

Certificate Programs

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 re-

Public Management

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 an M.P.A. degree.

The student will take one M.P.A. core course. The recommended core course is PA 502 - Leading and Managing Knowledge-Intensive Organizations.

AND at least 3 of the following:

- PA 511 Comparative Public Administration
- PA 516 Information Technology in Public
 - Administration

Nonprofit and Mission-Driven Management

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 an M.P.A. degree.

The student will take one M.P.A. core course. The recommended core course is PA 502 - Leading and Managing Knowledge-Intensive Organizations.

quire 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.

- PA 533 Advanced Financial Management for Public and Nonprofit Organizations
- PA 539 Local Government Management
- PA 540 Alternative Dispute Resolution
- PA 541 Performance Management in Nonprofit and Public Management
- PA 551 Public Infrastructure Management
- PA 556 Public Management Strategies for the 21st Century
- PA 562 Urban and Metropolitan Government
- PA 568 Strategic Competitiveness in the Public Sector
- PA 578 Planning and Policy Making and the Built Environment
- PA 579 Ethics & Professional Responsibility

AND at least 3 of the courses described above and below:

- PA 505 The Law and the Nonprofit Sector
- PA 533 Advanced Financial Management for Public and Nonprofit Organizations
- PA 540 Alternative Dispute Resolution
- PA 541 Performance Measurement in Nonprofit and Public Management
- PA 543 Public Policy, Nonprofits, and Philanthropy
- PA 556 Public Management Strategies for the 21st Century
- PA 565 The Nonprofit Sector
- PA 566 Nonprofits and the Public Sector
- PA 570 Social Capital and the Community
- PA 579 Ethics & Professional Responsibility

Security, Safety, and Risk Management

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 an M.P.A. degree.

The student will take one M.P.A. core course. The recommended core course is PA 502 - Leading and Managing Knowledge-Intensive Organizations.

AND 3 of the following:

- PA 536 Strategy and Structure: Homeland Security
- PA 537 Homeland Security/Crisis Management
- PA 538 Information Systems Security/Cyber-Crime
- PA 539 Local Government Management and Public Safety
- PA 553 Public Safety Administration
- PA 556 Public Management Strategies for the 21st Century
- PA 579 Ethics & Professional Responsibility
- PA 588 Incident Response, Disaster Recovery and Business Continuity

Dual Degree Programs

Several dual-degree programs are offered, including programs in which enrollees are eligible to earn a law degree from IIT Chicago-Kent College of Law. To help plan a program of study, students will be assigned advisers from both programs in which they are studying. Simultaneous enrollment is required for varying periods of time, depending on the program. Students should consult advisors 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

M.B.A./M.S. in Environmental Management and Sustainability

The M.B.A./M.S. in Environmental Management and Sustainability is designed to prepare professionals for management-level positions in corporations, government agencies and consulting firms. This program requires 22 semester courses of 3 credits each as specified by the Program Directors to fulfill this dual-degree program. The courses will be drawn from the M.B.A. and the M.S. in Environmental Management Programs.

M.B.A./M.S. in Marketing Analytics and Communication

The M.B.A./M.S. in Marketing Analytics and Communication program is designed to prepare students and working professionals who wish to pursue a career in marketing at the managerial or executive level at advertising agencies, public relations firms, and marketing firms or in the functional area of marketing at corporations. A com-

M.Des./M.B.A.

Offered in conjunction with the IIT Institute of Design, the Master of Design / Master of Business Administration (M.Des/M.B.A.) dual degree program combines graduate professional education in both design and business. The first program of its kind in the world, IIT's

M.B.A./M.P.A.

The Master of Public Administration program, designed for the working professional, emphasizes the formulation of policy, the acquisition of human and financial resources, and the application of sound methods of management in public and nonprofit organizations. The M.B.A./M.P.A. is ideal for students who intend to work in an environment that combines aspects of both publicof Law. Current GMAT or GRE scores are required by the Stuart School of Business, but current LSAT scores may be substituted in some programs. Interested students should contact program advisers from either program for other specific requirements.

All graduate programs in business are subject to continuous improvements including dual-degree programs. Prospective students are urged to refer to the Stuart Home page for the most current description of all programs and degree requirements.

This dual-degree program is typically completed in three years of full-time study or in five years of part-time study. Dual enrollment can reduce degree requirements by as many as five courses.

bination of 24 M.B.A. and M.S. in Marketing Analytics and Communication courses makes up the dual curriculum. Both degrees are usually earned in three years of full-time study or in five years of part-time study. Dual enrollment can reduce degree requirements by as many as three courses.

M.Des/M.B.A. marks an important milestone in the coevolution of design, management, and innovation. Please consult the M.B.A. Program Director or the Stuart website for the current requirements for this dual-degree program.

and private-sector management and for those who expect to move between business and government positions during their career. Both degrees are usually earned in three years of full-time study or in five years of part-time study. Please consult the M.B.A. Program Director or the Stuart website for the current requirements for this dual-degree program.
J.D./M.S. in Environmental Management and Sustainability

The Master of Science in Environmental Management and Sustainability integrates managerial and technical skills into Chicago-Kent's renowned Environmental and Energy Studies Program. This dual program is particularly well integrated because the two schools have offered it for about 10 years and have continually updated the courses and options for the students. Both degrees are usually earned in about three and a half years of fulltime study or in five to six years of part-time study. Dual enrollment is required in order to have courses apply to both programs and reduce the total course load.

J.D./M.B.A.

The J.D./M.B.A. program is offered in conjunction with Chicago-Kent College of Law. The management expertise and business skills that participants acquire in the M.B.A. program can be important skills in the legal profession. A solid understanding of the business world can be invaluable in many areas of law, especially for corporate attorneys or legal/management consultants. An M.B.A. degree prepares lawyers for management responsibility in their firm. Please consult the M.B.A. Program Director or the Stuart website for the current requirements for this dual-degree program.

B.S./M.P.A.

The requirements for the B.S. in Political Science/M.P.A. degree may be completed in five years of full-time study. Qualified students interested in careers in the public sector are encouraged to begin their preparation at the un-

J.D./M.P.A.

A J.D./M.P.A. program, offered in conjunction with IIT's Chicago-Kent College of Law, allows students to receive both a Juris Doctor degree and a Master of Public Administration degree in a reduced time period, depending on undergraduate preparation. This program is particularly valuable for administrators whose work is guided and circumscribed by a web of legislation, rules

M.B.A./M.P.A.

Many managers wish to increase their understanding of and ability to operate effectively in both the public and private sectors. This desire flows from the extensive interaction between the two sectors in such areas as procurement, contracting, consulting and economic development, as well as opportunities for career mobildergraduate level and follow a course of study that will allow them to move directly into the M.P.A. program. For detailed information, prospective students should contact the coordinator of the B.S./M.P.A. program.

and judicial decisions, including persons interested in city management, labor and personnel work, police administration, and public policy analysis. Students must be admitted to both programs separately. For detailed information, prospective students should contact the coordinator of the J.D./M.P.A. program, Professor Scott Peters.

ity. The dual-degree M.B.A./M.P.A. program reduces course requirements by as many as six courses from the requirements for the two degrees taken separately. For detailed information, prospective students should contact academic advisors and the Program Director at the Stuart School of Business.

Course Descriptions

Numbers in parentheses represent class, lab, and total credit hours, respectively.

Business

BUS 510

Building an Innovative & Sustainable Business

This is an introductory course on the fundamentals of doing business in an increasingly inter-connected and hypercompetitive world where rapid information flows, environmental degradation, and societal challenges (e.g., poverty and ethics) can be viewed as both threats and opportunities facing for-profit enterprises. Students will learn that sustainable businesses are also innovative businesses and that sustainability often drives innovation. Students will not only be exposed to the basics of starting, growing, and running a profitable business but also learn how to do so in an environmentally and socially sustainable fashion. They will learn how companies create and capture value and how to analyze the business environment, industry, competitors, and customers. They will be introduced to corporate, business, and functional strategy and learn about different business functions (accounting, finance, operations, marketing, and information management). Students will be introduced to critical challenges of global sustainability and will explore through case studies how leading companies are implementing triple bottom line accounting, sustainable growth, and stakeholder value creation strategies. Finally, they will develop an innovative business idea to start a brand new company that has sustainable growth in its mission statement. (3-0-3)

BUS 550

Business Analytics for Competitive Advantage

This course covers statistics, optimization, and simulation tools that are critical for managers in enabling their firms to have a competitive advantage. The course covers probability, sampling, estimation, hypothesis testing, linear regression, goodness-of-fit tests, linear optimization models, nonlinear optimization models, and managerial decision making under uncertainty. The models address problems in finance, marketing, and operations and include applications such as media selection, capital budgeting, portfolio selection, advertising effectiveness, facility location, distribution planning, and production planning. The focus of the course is on using business analytics to build models and using software to aid in decision-making. (3-0-3)

BUS 590

Business Innovation in the Next Economy

This is a forward-looking and experiential course that helps students understand how companies could successfully compete in the "next economy" through innovation and integrative problem-solving. It aims to integrate all of the key lessons from the MBA, MSEMS, and MSMAC 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 Student teams will present their findings to experts. fellow students, faculty members, and client companies. Prerequisite: Students should have successfully completed all of their respective program core courses.

(3-0-3)

Environmental Management and Sustainability

EMS 500

Fundamentals of Environmental Science

This is an introduction course designed to teach students without any background in environmental science, the fundamentals of environmental science which is the prerequisite knowledge needed for the EMS core courses. It covers basics of environmental science, calculus, chemistry, and other relevant topics that represent a needed foundation for the other courses in the program. Students with prior education in environmental science or related subjects could be waived out of this course with approval from the program director. (2-0-2)

EMS 501

Environmental Policy in a Competitive World

Environmental policies, the main tools that governments use to achieve environmental goals, cut across a wide swath of pollutants, industries, and stakeholders. Environmental policies affect the daily activities of every citizen and every business. Governments use environmental policy to protect their citizens' health, develop industries, preserve resources, increase national security, and 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 government often use to address environmental issues, the benefits and drawbacks of various approaches, 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. In addition, the course examines new direction in environmental policy, both policies gaining popularity and those not yet adopted. (3-0-3)

EMS 502

Contemporary & Emerging Laws Governing the Environment This course introduces students to major federal laws that govern the environmental performance of regulated facilities, sites, and activities. The course describes why these laws were enacted, how they are implemented by regulatory agencies, and the practical measures regulated entities must employ to achieve compliance. These laws include the National Environmental Policy Act, the Clean Water Act, the Clean Air Act, the Endangered Species Act, the Resource Conservation and Recovery Act, and the Comprehensive Environmental Response, Compensation, and Recovery Act. The review of these major federal laws will be informed by international and state initiatives that also affect decision making on environmental matters. The course will include a series of case studies and skill development sessions to introduce students to the practical realities of environmental management in a complex regulatory context. (3-0-3)

EMS 503

Environmental Pollution Prevention & Control Strategies

Greening organizations benefit both the firms and the society from eliminating/reducing pollution, inventing new processes, or reducing risks. This course focuses on the design and development of environmental management strategies specific to industrial operations and economic development activities in order to make them more competitive and sustainable. Specifically discussed in this course are the techniques and tools for mapping and characterizing industrial operation and economic development activities, identifying sources and types of environmental pollution, and defining steps involved with designing pollution prevention/control strategies and their alternatives (i.e., changing inputs, increasing efficiency, promoting innovation, or adopting new technologies to either prevent emissions or treat residuals). The economics of the pollution prevention/control including cost valuation and cost-benefit analysis are covered in addition to discussing the limitations and risks.

Prerequisite(s): [(EMS 500)] (3-0-3)

EMS 504

Industrial Ecology & Systems Thinking

This course introduces the students to the philosophy of industrial ecology and how this systems-based approach can move society toward a more sustainable future. Industrial ecology is an interdisciplinary field involving technology (science and engineering), public policy and regulatory issues, and business administration. The major goal of this course is to promote creative and comprehensive problem solving as it might be applied to product, business, and systems models. The course introduces tools such as industrial metabolism, input-output analysis, life cycle assessment, and design for the environment. Individual and team projects are a significant part of the learning experience in this course. Prerequisite(s): [(EMS 500)]

(3-0-3)

EMS 505

Environmental Finance

The emerging field of environmental finance provides businesses an opportunity to approach environmental challenges in a financially sustainable and often profitable manner. The course will introduce students to fundamental concepts of microeconomics, macroeconomics, and accounting in order to prepare them for studying finance and other EMS courses. It will explore implications of environmental finance on the financial sector ranging from banking, insurance, investments, financial services, sustainable investing, and social enterprise. The role of hedging devices for pollution and energy and the role of corporate advocacy in environmental policy and standards will be addressed from a corporate competitive business strategy perspective. The interrelationship between financial and environmental performance will be discussed with a focus on corporate risk management and impact on stock and bond ratings. Format will comprise of introduction of basic concepts, discussion of select current publications from corporate and academic thought leaders, and cases or examples that provide hands-on experience.

Prerequisite(s): [(BUS 510 and EMS 500)] (3-0-3)

EMS 511

Solid & Hazardous Waste Management & Remediation

The aim of this course is to teach the modern multi-faceted approach of the management of solid waste focusing on the generation and prevention (emphasis is on understanding what waste is, where it comes from, how/why it is generated, and how generation of waste can be reduced), re-use and recycling (once waste is generated, what can be done to make use of those waste components that are of economic interest), treatment (discuss the three most important treatment/disposal methods presently in use both in the less and the more developed world, landfills, incineration, and mechanical/biological treatment), and disposal of waste (examples include analysis and environmental impact assessment of land-filling and incineration). RCRA technical and regulatory points of views are covered, and discussed are evolution of RCRA legislation, components of RCRA, and its interrelationship to other environmental statutes CERCLA, SARA, and DNR hazardous waste permitting. Also discussed are the fundamentals of remedial actions, Brownfield's redevelopment, and renewable energy. The emphasis would be on the economic, social, and environmental costs of waste generation, recycling, treatment, and storage. Prerequisite(s): [(EMS 503)]

(3-0-3)

EMS 512

Environmental Risk Assessment & Management

The course provides an overview of the tools and techniques used to (1) assess environmental (human health), ecological, and occupational risks associated with exposure to environmental pollutants resulting from natural phenomena, economic development, and industrial growth, (2) examine current risk management and mitigation methods and strategies, and (3) design visionary risk management strategies grounded on a framework of operations in line with the principles of sustainable development. Prerequisite(s): [(EMS 503)]

(3-0-3)

EMS 513

Environmental Economics & 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 intuition economic solutions to address environmental problems such as climate change, global warming, and water scarcity. Prerequisite(s): [(EMS 505)]

(3-0-3)

EMS 518

Ethics & Corporate Social Responsibility

The corporate scandals and implosions of the past decade. climaxing in the recent global financial crisis and environmental disasters, have highlighted how critical ethical, environmental, and socially responsible decision making and leadership are to the long-term survival and success of both individual businesses and society. Concomitantly, role of business is transforming from meeting a social contract to realizing tangible economic gains by creating shared value. In today's global environment, societal needs are defining markets, and key issues include poverty, hunger, water, sustainability, climate change, and MNC roles in developing economies. Ethical issues include bribery, fraud, and green washing all the way to a culture of corruption. Corporations and leaders have to manage corporate social responsibility not just as a moral obligation or risk/reputation management exercise but as an integration into their global strategy. This course will endeavor to teach students how these issues get integrated in business through strategy and structure and how to build new competencies in managing transparency, accountability, stakeholder engagement, ethics culture, and social innovation that are critical for business success in the next economy.

Prerequisite(s): [(BUS 510)] (3-0-3)

EMS 525

Environmental Performance Analytics

With increasing focus on sustainability factors from marketplace (regulators, investors, financiers, and consumers), corporate sustainability reporting is shifting from voluntary to vital. Advances in enterprise systems are making it feasible for corporations to track, trend, and transform sustainability performance. Materiality of these seemingly non-economic impacts is the critical link between sustainability and business strategy. This course provides insight into how to determine which environmental metrics are material to them and relevant to their business through application of environmental performance analytics. Format will comprise of introduction of basic concepts, discussion of select current publications from corporate and academic thought leaders, and short cases or examples that provide a hands-on experience. Students completing this course will develop a better understanding of the materiality of interrelationships between business and sustainability. In particular, they will equip themselves with the ability to apply data collection, analytics, and quantitative justification to promote select sustainability improvements that are consistent with corporate strategy. This will help them to be better prepared to take on greater responsibilities in a consulting or advisory role to the corporate sector. Prerequisite(s): [(BUS 550)] (3-0-3)

EMS 529

Social Entrepreneurship

This course gives students a practical introduction to the exciting and rapidly growing field of social entrepreneur-The course will begin by introducing students to ship. contemporary understandings of poverty, its causes, and It will then traditional poverty alleviation strategies. turn to key concepts regarding social ventures including entrepreneurship, organizational structure (for-profit, nonprofit and hybrid), financing, marketing, and performance assessment (social and environmental impact). The course will also examine the challenges that are faced in creating and operating social enterprises in different parts of the world. The course includes guest lectures by other Stuart School of Business faculty and social entrepreneurs working in different areas (such as health, education, and environment). Students will gain hand-on experience by either developing a business plan for a social enterprise to address a specific real world problem or assisting an existing social venture in developing a business plan geared towards an expansion of its services: it is expected that the plans can be entered into a variety of social venture competitions. Through the course, students will learn how to do the following: (1) evaluate gaps and opportunities in a given context; (2) develop appropriate objectives and strategies for a social venture; (3) put together a business plan for a social enterprise; and (4) engage others and foster buy-in to their plans. Prerequisite: Instructor consent.

(3-0-3)

EMS 531

Environmental Advocacy

This course explores how individuals, firms, nonprofits, and others advocate in order to achieve environmental goals using a broad range of advocacy tools in the legislative, regulatory, administrative, political, judicial, and educational arenas. The course examines when, where, and how advocacy can be effective, strategies for framing policies, how to evaluate legal and ethical factors, and how to use traditional as well as grassroots, social networking, and other evolving new media methods to support an advocacy campaign. Prerequisite(s): [(EMS 501)]

(3-0-3)

EMS 532

Environmental & Energy Law Clinic

This course provides students with the opportunity to experience the practical realities of being an environmental professional by working on actual cases under the supervision of a faculty member who is an experienced environmental attorney with a Chicago-based practice. The course includes weekly classroom sessions to build the skills environmental professionals must possess. Students apply these skills to cases in the Chicago area in which the faculty supervisor represents non-governmental organizations. The Clinic includes opportunities to participate in site visits, client interactions, a variety of professional meetings, and regulatory and enforcement proceedings. Students will engage in fact gathering, compliance analysis, client communication and case preparation activities, working alongside their faculty supervisor.

Prerequisite(s): [(EMS 502)] (3-0-3)

EMS 541

Managing Energy Technologies

A significant focus of this course will be on what environmental managers and business managers need to know regarding the technical aspects of energy management – energy efficiency and fossil and renewable energy technologies. The thrust of the course will be in understanding current and emerging technologies in this rapidly growing area of business and industry. However, students will not need to have technical or engineering background to do well in this course.

Prerequisite(s): [(EMS 500)] (3-0-3)

EMS 542

Economics of Energy Systems

Students will see the big picture economics of energy management – cost of production/distribution, financing renewable investments, climate change, etc. Students will understand the economic, strategic, and management issues surrounding energy management and have an opportunity to learn new tools and techniques.

Prerequisite(s): [(EMS 500)] (3-0-3)

EMS 595

Special Topics in Environmental Management & Sustainability This course covers contemporary or cutting edge topics in the EMS field offered on an irregular basis typically in a seminar style. Prerequisite: Instructor permission. (3-0-3)

EMS 597

Independent Study in Environmental Management & Sustainability

Students can conduct in-depth research, usually on an independent and solo basis, under the guidance of a full-time faculty member. Typically student signs up with a faculty member who is willing to supervise his/her independent research on a particular EMS-related topic. The student has to complete the independent study form, develop a one-page proposal outlining the purpose, process, and product (expected outcomes) of the independent research project, get the faculty member's approval, and submit it to the program director approval. Prerequisite: Instructor and program director approval. (0-0-3)

Management Science

MSC 511

Economics I

This is the first of a two-semester sequence in advanced level economics. It offers a rigorous treatment of modern microeconomics theory which includes consumer theory, theory of the firm, decision making under uncertainty, and game theory. The course examines various market settings such as competitive markets, oligopolies, and monopolies. Other topics considered include consumer preferences and production functions, choice under uncertainty, various measures of welfare and efficiency, equilibrium concept,s public goods, externalities, mechanism design, adverse selection, and moral hazard. Focus is on major topics of economic analysis and the tools used to study them. Some mathematics background, particularly calculus, is essential. (3-0-3)

MSC 512

Statistics 1

This course provides a comprehensive introduction to the statistical approach to tackling research problems (random variables; transformations; popular distributions used in management science such as normal, Student T, Chi-square, and generalized lambda; sampling methods, parameter estimation, confidence intervals and joint confidence intervals, hypotheses testing, sample size and power, regression and correlation), and statistical modeling. It will focus on the mathematics of differential equations, stationary time series models, conditional heteroscedasticity, non-stationary time series, cointegration and non-linear models. Students will also learn techniques like maximum likelihood estimation, likelihood ratio tests, and generalized method of moments estimation. Students will be introduced to stochastic processes and applied probability, Bayesian statistics, computational inference, extreme value theory, survival analysis, design of control and cohort experimental studies, introduction to SAS statistical software, issues in data-screening/diagnostic testing, model specification and estimation issues and empirical analyses involving large databases. (3-0-3)

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.

(3-0-3)

MSC 514

Economics II

This is the second course in the two course economics core sequence. It provides a basic introduction to game theory and explores its use in modern economics and business through examinations of classic and current papers. It covers the nature and existence of equilibrium in static and dynamic games, repeated games, and implications of asymmetric information including signaling, adverse selection and moral hazard and there application to modern business problems in finance, operation research and marketing. it also introduces students to models used in modern macroeconomics. Prerequisite(s): [(MSC 511)]

(3-0-3)

MSC 515

Statistics II

This course focuses on econometrics, with a special emphasis on regression analysis. It begins with the classical linear regression model and variations based upon non-linearity, non-normality, heteroscedasticity and autocorrelation. The course also includes a discussion of cross-section data, systems of regression equations, dynamic regressions, and models with discrete dependent variables. The course emphasizes in-sample and post-sample forecasting and hypothesis testing. The course is heavily project oriented and students will be expected to work with modern statistical packages like R, SAS, SPSS and RATS. Projects will be drawn from financial and business applications.

Prerequisite(s): [(MSC 512)]

(3-0-3)

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)] (3-0-3)

MSC 611

Philosophy of Management

This new course introduces doctoral students to the history and evolution of thinking in the management discipline. It will focus attention on theories of leadership and innovation, and showcase contributions of influential thought leaders in management. It will also showcase epistemological perspectives with substantial potential for enhancing business research. Finally, it addresses fundamental approaches and criteria for successful theory development. (3-0-3)

MSC 612

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.

Prerequisite(s): [(MSC 601, MSC 602, MSC 603, MSC 604, MSC 605, and MSC 606)] (3-0-3)

MSC 621

Corporate Finance

This course describes how corporations use financial decisions to create shareholder value. Topics include net present value calculations, real options theory, equilibrium models of required rates of return, capital structure, and dividend policy. The course also covers the use of financial theories in organization structure through mechanisms like economic value added, enterprise risk management, and mergers and acquisitions. This course offers a more formal mathematical presentation of corporate finance than is found in similar courses in master level programs. Prerequisite(s): [(MSC 601)]

(3-0-3)

MSC 622

Enterprise Risk Management

This course focuses on the two main solos 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, extreme and tail events modeling. Prerequisite(s): [(MSC 602 and MSC 631)] (3-0-3)

MSC 631

Theory of Finance

This course covers basic theoretical work on asset pricing. The course begins with economic theories related to the demand for risky assets and introduces concepts like risk aversion and risk measurement. The course then develops the primary equilibrium models of asset valuation including CAPM, Arrow-Debreu, and consumption CAPM. The course also covers arbitrage pricing theory, optimal growth models, and the theory of corporate financial structure. (3-0-3)

MSC 632

International Finance Theory

Prerequisite(s): [(MSC 605 and MSC 631)](3-0-3)

MSC 641

Operations I

This elective course will focus on special topics in the Operations area that are best aligned with the research interests of the instructor(s). More specifically, these may address the management of quality and related aspects such as the economics of quality (returns to investment in quality) and the management of customer satisfaction. Prerequisite(s): [(MSC 601, MSC 602, and MSC 603)]

Prerequisite(s): [(MSC 601, MSC 602, and MSC 603)] (3-0-3)

MSC 642

Operations II

This elective course will focus on special topics in the Operations area that are best aligned with the research interests of the instructor(s). More specifically, this course addresses supply chain management and related inventory management issues.

 $\ensuremath{\mathsf{Prerequisite}(s)}\xspace:$ [(MSC 601, MSC 602, and MSC 641)] (3-0-3)

MSC 691

Research & Thesis PhD

Research and thesis writing. (Credit: Variable)

Marketing Analytics and Communications

MAC 501

Insights Into the Next Economy Markets

This course analyzes competitors, industries, and customers in the emerging global business environment. Understanding the demographics and psychographics of target audiences is essential to an effective marketing communication strategy. From data to information to insightful strategic marketing, this course covers what's important to know to make more effective marketing decisions. Social, cultural, psychological, and attitudinal factors are explored with particular attention to motivation, how attitudes are shaped and altered, how information is processed, and the role of learning in the formation of purchasing decisions. Theories and models of consumer behavior are examined to develop incisive insights 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. (3-0-3)

MAC 502

Spreadsheet Modeling

Spreadsheets are a popular model-building environment for managers. Add-ins and enhancement 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. (3-0-3)

MAC 503

Marketing Research & 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): [(MAC 501)]

(3-0-3)

MAC 504

Creating, Communicating, & Delivering Customer Value

This course provides an introduction in the practice and strategy of marketing. Marketing activities are those processes and functions that enable managers and policy makers to identify and serve the values and needs of a customer given the capacities of the company, activities of competitors, and inherent constraints in the business environment. Marketers typically refer to these concepts as the "four C's." Based on their understanding of the "four C's," students will then learn how to implement strategy by applying the levers of the marketing mix. These elements are known as the four P's (product, price, place/channels of distribution, and promotion). The treatment of marketing constraints and marketing mix will be motivated by essential foundations from economics, sociology, and consumer behavior. Over the course of the semester, students are expected to transition from thinking about these concepts in isolation to a dynamic, integrative framework. This process includes using the marketing strategy framework to assess business and policy problems from a "multiple objective" perspective: that is, the student will be asked to think about how marketing activities along with those of competitors and collaborators will affect the profitability, sustainability, social, and ethical standing of the firm. The synthesis of these concepts will be carried out through the use of case studies, problem sets, classroom lectures, discussions, and a field project. There will also be a midterm and final exam. The pedagogical style of the course emphasizes the students' role in applying the concepts discussed in the lectures to the situations at hand. The role of the instructor is to provide tools to structure thinking and to stimulate and facilitate analysis of the cases.

Prerequisite(s): [(BUS 510 and MAC 501)] (3-0-3)

MAC 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. 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 In addition to the development of a marketing strategy. 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): [(MAC 504)] (3-0-3)

MAC 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): [(MAC 504)]

(3-0-3)

MAC 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): [(MAC 511)]

(3-0-3)

MAC 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): [(MAC 511)]

(3-0-3)

MAC 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): [(MAC 511)]

(3-0-3)

(0-0-0)

MAC 515 Database & 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 directto-consumer/direct-to-business tools including electronic marketing.

Prerequisite(s): [(MAC 511)] (3-0-3)

MAC 516

Social Media Marketing Strategy

The areas 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.

Prerequisite(s): [(MAC 511)] (3-0-3)

MAC 521

Qualitative & Survey Research Methods in Business

This is an introductory course in qualitative and survey methods relevant to basic and applied research problems in businesses (with a focus on marketing). Although this is an introductory course, students should be prepared to engage seriously in how qualitative research is conceived, conducted, implemented, and interpreted in business contexts. The course does not emphasize statistical methods, and ability to quickly acquire working knowledge of basic statistics is assumed. The instructor will make an effort to work with students to cover essentials. Students will also require a good understanding of substantive business contexts. In short, while the course accomplishes several objectives, it will focus on the skills required to design and conduct research studies using qualitative and/or survey methods. Prerequisite(s): [(BUS 550)]

(3-0-3)

MAC 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)] (3-0-3)

MAC 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)] (3-0-3)

MAC 595

Special Topics in Marketing Analytics & Communication

This course covers contemporary or cutting edge topics in the marketing analytics and communication field offered on an irregular basis typically in a seminar style. Prerequisite: Instructor permission. (2,0,2)

(3-0-3)

MAC 597

Independent Study in Marketing Analytics & Communication Students can conduct in-depth research, usually on an independent and solo basis, under the guidance of a full-time faculty member. Typically student signs up with a faculty member who is willing to supervise his/her independent research on a particular MAC-related topic. The student has to complete the independent study form, develop a onepage proposal outlining the purpose, process, and product (expected outcomes) of the independent research project, get the faculty member's approval, and submit it to the program director for approval.

(0-0-3)

MBA Business

MBA 501

Accounting for Strategic Decision Making

This course is an introduction to the basic financial and managerial accounting topics (GAAP, the major financial statements, accrual accounting, financial reporting alternatives, professional ethics, financial statement analysis, cost behavior, cost systems, short-and long-term decisionmaking with strategic considerations, and product costing) and a review of environmental accounting. (3-0-3)

MBA 502

Emerging Issues in the Global Business Environment

The course helps students understand the complexities of the globally interconnected world of business they will be working in 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. (3-0-3)

MBA 504

Spreadsheet Modeling

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. (3-0-3)

Contemporary Economic Analysis & 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.

Prerequisite(s): [(BUS 510)] (3-0-3)

MBA 506

Leading & Managing Knowledge-Intensive Organizations

This course 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 design 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): [(BUS 510)] (3-0-3)

MBA 509

Financial Management in a Globalized World

In this course, the student will learn the concepts and processes that underlie enlightened financial decision making in a global world. Students will explore how to raise debt and equity capital, how to think about what portion of earnings to retain and reinvest and whether to share some earnings with stockholders via dividend payments or repurchase of shares, how to value stocks and bonds, how to distinguish good from bad financial decision rules, how to decide which projects a firm should engage in, how to use futures, options and swaps to manage firm risk, how to ensure good corporate governance, why sustainability can be profitable while still protecting future generations, and how to manage the financial decisions required to effectively operate in a global setting.

Prerequisite(s): [(BUS 510 and MBA 501)] (3-0-3)

MBA 511

Creating, Communicating, & Delivering Customer Value

This course provides an introduction in the practice and Marketing activities are those strategy of marketing. 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)] (3-0-3)

Operations & Technology Management

The course seeks to help the student develop an understanding of the concepts and skills needed for the design and control of operations in both services and manufacturing organizations. Students will take a strategic and general management approach to the design of an operating system and its supporting organizational structure and infrastructure including information systems, human resource management, and financial policies. The focus is on the strategic role of operations and technology decisions as a source of competitive advantage for the firm with an emphasis on the integration of R & D/Design/Engineering, operations and marketing within the context of the business unit's strategy, and the organizational structure and skills needed to execute and manage the operating system. The overal goal is to create, achieve, and sustain operational effectiveness. The course will emphasize the analytical tools and techniques that are useful in making decisions about projection facilities and capacity, choices of technology and equipment, task and process design, organizational architecture, human resources policies, and the physical and managerial control of operations. Students will gain an understanding of the economics of operations including trade-offs between fixed and variable costs, marginal/incremental analysis to identify relevant versus sunk costs, optimization, and productivity measurements for both capital and labor. Case studies will provide opportunities for students to develop their skills in process design and choice, process mapping, critical thinking, identification of problems versus symptoms, process improvement, and capacity measurement in the context of the business strategy while the simulations will provide an opportunity to practice the management of a particular operating system. Students will also gain an understanding of how human behavior and organizational design, along with quantitative optimization, forms the theoretical underpinning of operations management.

Prerequisite(s): [(BUS 510)] (3-0-3)

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. (3-0-3)

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. Prerequisite: Completion of program core or instructor permission. (3-0-3)

MBA 523

Negotiations & 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 The theoretical component is focused on an strategies. 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. (3-0-3)

MBA 524

Leadership in Multicultural Organizations

Managerial leadership is one of the primary drivers of an organization's success. Not surprisingly, organizations are demanding effective leadership skills from managers at all levels. This course is designed to enhance students' understanding of leadership in contemporary organizations. Students will develop a conceptual framework of effective leadership in multinational organizations. Besides discussing leadership skills and traits, particular attention will be devoted to exploring the influence of organizational and societal context on leadership. This course will be taught with an experiential learning approach. Through selfassessments, case analyses, and a variety of other exercises, students will augment their leadership skills. Prerequisite(s): [(MBA 506)]

(3-0-3)

Sustainable Supply Chain Management

We will present models and practices that minimize supplydemand 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 discussed topics involved in the interaction of a firm with others players in a supply chain such as valve of information, supply contracts, and risk sharing. Finally, the course will introduce models/tools enabling sustainability actions plans, for example, reducing waste in the supply chain, both upstream and downstream. pre-requisite: MBA507. (3-0-3)

MBA 528

Healthcare Management, Technology, & Innovation

Healthcare is one of the most fundamental human problems around the world. Besides food and water, every one of the seven billion people on earth needs healthcare. Yet, the current systems of healthcare delivery have inadequacies in providing quality care to all. In this respect, technological innovations have begun to contribute creative solutions to the many problems that healthcare delivery systems face with access to care, affordability of care, and consistent quality of care. This course focuses on how the management of technology and innovation and business and strategy principles can converge to understand the trends, problems, and potential solutions to the American healthcare delivery system and to other systems around the world. The course aims to acquaint the student with the issues and potential solutions of managing the healthcare delivery system. The healthcare sector has unique characteristics as both a social and business enterprise where private and public organizations and enormous resources are involved. The student will gain knowledge about the structure of the healthcare delivery system and how technology and innovation are contributing to some solutions to its most pressing problems of access, affordability, and quality of care. The student will also gain knowledge about the key technology dimensions and forces that shape the industry. Prerequisite(s): [(BUS 510)]

(3-0-3)

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. (3-0-3)

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)]

(3-0-3)

MBA 564

Competing in Emerging Markets

For Western MNCs, some of the most intriguing growth opportunities in the "next economy" exist in low-income segments, the so-called markets at the bottom of the income pyramid, in emerging and underdeveloped countries of the world. Historically, MNCs targeted the customers at the top of the pyramid in these countries because their business models worked well for them. But as these bottom-ofthe-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)] (3-0-3)

MBA 566

Understanding China: History, Politics, & Economics

While the 21st century may or may not be called the Chinese century, there is no doubt that China has become a dominant political, economic and business force on the global stage. The fastest and the largest markets for many products and services are located in China. The supply chains for most manufacturing industries pass through China. Increasingly, China is becoming the base for high value-added activities, such as research and development. The center of economic gravity is shifting to China, and every aspiring business executive needs to understand China and how to do business with it. In this course, students learn about China's history, politics and economics. Pre-requisite: Instructor Consent. (3-0-3)

MBA 567

Chinese Language & Culture

The course provides non-Chinese business people an understanding of the Chinese language, culture, ethnic diversity, and traditions. Understanding culture is an essential first step to understanding business practices and customs. S o the ultimate objective of this course is to help non-Chinese business people understand how to effectively deal with Chinese customers, suppliers, and business partners. (3-0-3)

Competitiveness of Asian & Western Enterprises

This course helps students understand the economic context within which Asian enterprises and Western enterprises evolved and how they tend to compete on very different factors. While many business principles are universal, the key drivers of competitiveness differ substantially between Asian and Western enterprises. More importantly, within these groups there could be significant nationality-based differences. The course provides an insightful comparative study of companies based in opposite ends of the world and help students understand why they employ different sets of strategies to compete and succeed on the global stage. Pre-requisite: Instructor Consent (3-0-3)

MBA 570

Business Study Mission to China

China has become a major business destination for companies from 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. Prerequisite: Instructor permission. (3-0-3)

MBA 575

Creativity & 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 strategy 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)]

(3-0-3)

MBA 576

Creating & Financing New Technology Ventures

The course concentrates on the study of entrepreneurship, preparation of business plans, methods for evaluating and screening new venture ideas, formulation and implementation of business strategies for new ventures, development of a business plan, the financing of new ventures, and venture growth strategies and exits. It integrates knowledge gained from the prior core business courses (i. e., management, marketing, finance, and accounting) to sharpen the student's ability to think entrepreneurially and form new ventures. The course will also focus on identifying, examining, and evaluating various sources of original and growth capital. Emphasis will be on legal, financial, and tax issues related to capital formation as well as specific problems experienced by the small-to-medium-sized firm undergoing rapid growth in the high technology space. Topics discussed will include venture valuation, financing startups, financial planning and strategy, going public, selling out, and bankruptcy. A formal proposal for capital acquisition developed through field research will be required of each student. Prerequisite(s): [(BUS 510)]

Prerequ (3-0-3)

MBA 577

Got Creativity?: Strategies & 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. (3-0-3)

MBA 581

Marketing Research & 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)] (3-0-3)

Strategic Marketing Management

In this course we will emphasize both marketing strategy formulation and execution and the management of the marketing function. This includes the integration of marketing mix decisions, the longer-term effects of marketing mix decisions, and changes in the mix over time. For example: "Price" becomes price policy, value-in-use, and price discrimination; "Product" becomes product line breadth and variety and product life cycle choices; "Place" becomes the design and control of single or multiple channels of distribution: and "Promotion" becomes communications. customer loyalty, and brand equity. The course will emphasize segmentation of the market, positioning the marketing mix to meet the needs of the market segment, sustaining an integrated marketing mix over the product life cycle, and organizing the strategic business unit to implement the strategy. In addition to the development of a marketing stategy that positions the product/service to the needs of one or more target markets (segmentation), the execution of a marketing strategy will require a marketing plan that includes the economic and financial analysis of the costs and potential profits of the strategy and an implementation plan, including an organizational structure. This will often be an iterative process to find an optimal combination of costs, pricing, and volume to maximize profits. This course will use readings, simulations, and cases for about half its content. The other half of the course will be a team consulting project for an external client.

Prerequisite(s): [(BUS 510)] (3-0-3)

MBA 587

Nonprofits & 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.

(3-0-3)

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.

(3-0-3)

MBA 589

Regulatory Politics & 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. (3-0-3)

MBA 595

Special Topics - MBA Prgm

Special topics. (3-0-3)

MBA 597

Independent Study in Business Administration

Independent study. (Credit: Variable)

Master of Science in Finance

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). (3-0-3)

(0 0 0)

MSF 502 Statistical Analysis in Financial Markets

This course presents the major conclusions of the econometric techniques used in finance. Ordinary least squares, maximum likelihood, generalized method of moments, and simulation methods are covered. These tools are presented through computer simulation of the various models, followed by detailed analysis of the distributions of estimators. Hypothesis testing is covered in detail. Particular attention is placed on the properties of various estimators when model assumptions do not hold. For students who qualify, a final project applying econometrics to a financial modeling problem may be chosen. Students not familiar with matrix algebra and elementary statistics should plan to make up the deficit early in the course. Additional lectures will be provided for these students. (3-0-3)

MSF 503 Financial Modeling

This course presents the major conclusions of the econometric techniques used in Finance. Ordinary least squares, maximum likelihood, generalized method of moments, and simulation methods are covered. These tools are presented through computer simulations of the various models, followed by detailed analysis of the distributions of estimators. Hypothesis testing is covered in detail. Particular attention is placed on the properties of various estimators when model assumptions do not hold. For students who qualify, a final project applying econometrics to a financial modeling problem may be chosen. Students not familiar with matrix algebra and elementary statistics should plan to make up the deficit early in the course. Additional lectures will be provided for these students.

(3-0-3)

MSF 504

Valuation & 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 courses places a special emphasis on the relationship between macroeconomic conditions and investment opportunities. Prerequisite(s): [(MSF 501, MSF 502, and MSF 503)] (3-0-3)

MSF 505

Futures, Options & OTC Derivatives

This course provides the foundation for understanding the price and risk management of derivative securities. The course starts with simple derivatives, e.g., forwards and futures, and develops the concept of arbitrage-free pricing and hedging. Based upon the work of Black, Scholes, and Merton, the course extends their pricing model through the use of lattices, Monte Carlo simulation methods, and more advanced strategies. Mathematical tools in stochastic processes are gradually introduced throughout the course. Particular emphasis is given to the pricing of interest rate derivatives, e.g., FRAs, swaps, bond options, caps, collars, and floors.

Prerequisite(s): [(MSF 501, MSF 502, and MSF 503)] (3-0-3)

MSF 506

Financial Statement Analysis

After reviewing the content of the major financial statements, the course examines ratios, inventories, long-lived assets, income taxes, debt, leases, and pensions, among other topics. U.S. practices are compared to practices in other major countries. This course is intended for those who will examine financial statements of outside organizations.

Prerequisite(s): [(MSF 501, MSF 502, and MSF 503)] (3-0-3)

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. Pre-requisites: MSF 503 required, MSF 505 recommended. Prerequisite(s): [(MSF 504 and MSF 505)]

(3-0-3)

MSF 525

Term Structure Modeling & Interest Rate Derivatives

Upon completion of this course, students should know the strengths, weaknesses, appropriate uses, and ways of implementing the major term structure models that are in common use. The course will begin with bootstrapping of forward curves, principal component analysis, and a review of basic fixed income derivatives (swaps, swaptions, caps, and floors). We will then implement short rate models, such as Ho-Lee, Black-Derman and Toy, and extended Vasicek/Hull-White, followed by the Helath-Jarrow-Morton model and market rate models. Students will implement these term structure models in Excel/VBA and Matlab. Prerequisite(s): [(MSF 504 and MSF 505)] (3-0-3)

MSF 526

Computational Finance

Prerequisite(s): [(MSF 504 and MSF 505)] (3-0-3)

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: MSF 506

Prerequisite(s): [(MSF 504, MSF 505, and MSF 506)] (3-0-3)

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: MSF 506.

 $\ensuremath{\mathsf{Prerequisite}}(s) \colon [(\ensuremath{\mathsf{MSF}}\xspace{505}, \ensuremath{\mathsf{and}}\xspace{\mathsf{MSF}}\xspace{506})] \ensuremath{(3-0-3)}\xspace{3}$

MSF 543

Alternative Investments

Alternative investments include real estate, hedge funds, managed futures, and emerging markets. They are attractive to institutional investors because they exhibit a low correlation with traditional investments in stocks and bonds. However, they must be approached cautiously because of specific difficulties in valuing these assets. This course will explore a variety of alternative investments and their role in investment strategies.

Prerequisite(s): [(MSF 504 and MSF 505)] (3-0-3)

MSF 544

Equity Valuation

This course covers the various models available for equity valuation. It includes discussions of the dividend discount model, Porter analysis, DuPont decomposition of ROE, sustainable growth rates, earnings quality, and accounting fraud. It also covers relative valuation measures such as price/earnings and price/sales ratios. The valuation techniques taught in the course will be applied to the valuation of equity shares, corporate bonds, and derivatives such as stock options and convertible bonds. Completion of a comprehensive analysis of a public company is a requirement for the course. This course is recommended for students who are planning on sitting for Certified Financial Analyst (CFA) qualification.

Prerequisite(s): [(MSF 504, MSF 505, and MSF 506)] (3-0-3)

MSF 545

Structured Fixed Income Portfolios

This course will cover the characteristics, valuation and risk management of fixed income instruments. These instruments include bonds, repos, interest rate derivatives, inflation indexed securities, mortgage-backed and asset-backed securities, CDOs and default swaps. The focus will be on understanding how these instruments are structured and used. Term structure modeling and hedging techniques will be presented, with a minimum of mathematics.

Prerequisite(s): [(MSF 504 and MSF 505)] (3-0-3)

MSF 546

Quant Investment Strategies

This course develops the primary quantitative tools used in the portfolio selection process. The applied focus of the course centers on the process of moving from a data set of historical information to the formulation of a forecasting model, the estimation of mean-variance efficient portfolios, and the testing of efficiency hypotheses within an in-sample and post-sample setting. The course covers the estimation of efficient portfolios, factor models, forecasting models, and risk analysis.

Prerequisite(s): [(MSF 504 and MSF 505)] (3-0-3)

MSF 549

Commodities & 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 The value of commodities in the institutional markets. portfolio will be presented, which may allow hedging against inflation and the risks of declining stock and bond prices. Commodity trading advisers, commodity pool operators and the managed futures industry will be discussed. These fund managers initiate both long and short positions in futures markets, typically constructing portfolios from either a systematic or discretionary perspective. Prerequisite(s): [(MSF 504 and MSF 505)]

(3-0-3)

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 MSF 505. Prerequisite(s): [(MSF 504, MSF 505, and MSF 506)] (3-0-3)

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 MSF 505. Prerequisite(s): [(MSF 554)]

(3-0-3)

MSF 556

Enterprise Risk Management

This course follows up on FIN 581 (Market Risk Management). It focuses on the other 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 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 and scenarios analysis, extreme and tail events modeling. Prerequisite: MSF 505.

(3-0-3)

MSF 564

Financial Theory

This course covers the foundations of financial economics and the theoretical underpinnings of contemporary asset pricing models. We will explore the many uses and extensions of the fundamental pricing equation: , where Pt is the current price, is the pricing kernel or stochastic discount factor, and is a future random payoff. The ?art? of asset pricing is in how one specifies the functional form of the pricing kernel. With different assumptions yields the Capital Asset Pricing Model, the Consumption-CAPM, the Black-Scholes-Merton option-pricing model, and many popular term structure models. The Consumption-CAPM does not fair well in the empirical literature motivating the study a promising group of next-generation risk/return models. The latter part of the course will be devoted to continuous-time asset pricing of options and the modeling of the term structure. The emphasis will be on risk-neutral, Martingale pricing methods, rather than solving partial differential equations. This material is a theoretical complement to the Computational Finance and Financial Modeling sequences. Prerequisite: MSF 501. (3-0-3)

MSF 565

International Finance Theory

This course will focus on the determination of prices, interest rates and exchange rates within the context of neo-classical equilibrium models. The theoretical foundations of the course will be supplemented by extensive exercises in econometric testing of maintained hypotheses and exercises in real time trading. Prerequisite: MSF 501. (3-0-3)

MSF 566

Time Series Analysis

This course develops a portfolio of techniques for the analysis of financial time series. Distribution theory covers the normal, student T, chi-squared, and mixture of normal models. Technical analysis covers a variety of trading rules including filters, moving averages, channels, and other systems. The first two topics are then combined into an analysis of non-linear time series models for the mean. The course concludes with a review of volatility models including GARCH, E-Garch and stochastic volatility models.

Prerequisite(s): [(MSF 504 and MSF 505)] (3-0-3)

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 deficit early in the course. Prerequisite: MSF 502. Prerequisite(s): [(MSF 504 and MSF 505)] (3-0-3)

MSF 574

.NET & Database Mgmt.

The course provides students with a comprehensive knowledge of .NET (VB and C#) programming, relational database design and SQL as they apply to quant finance and real-time trading. Specifically, topics covered include the .NET framework and libraries, ADO.NET, OOP, generics, market data feeds, XML and the Unified Modeling Language, as well as an overview of the hardware and network infrastructure necessary to enable electronic trading.

Prerequisite(s): [(MSF 504 and MSF 505)] (3-0-3)

MSF 575

C++ with Financial Mkts

This course presents the C/C++ programming language. Students learn the language from the ground up, from data types, to functions, arrays, classes, dynamic memory management, data structures and the Standard Template Library. Object-oriented programming is also discussed, including a review of commonly used design patterns. The focus is to understand C/C++ as it applies to financial mathematics and several practical examples from computational finance are presented.

Prerequisite(s): [(MSF 504 and MSF 505)] (3-0-3)

MSF 576

OOP & Algorithmic Trading Systems

In this course, students learn advanced programming topics in .NET for real-time financial applications and automated trading systems, including multithreading, sockets, APIs, synchronization, the FIX and FAST protocols, and object oriented design for event-driven applications. Also, project management and software quality are covered in depth. Lastly, topics related to latency in real-time financial applications and alternative network architectures are also discussed. Students are expected to propose, design, document and develop an original project combining concepts from quantitative finance and trading strategy (presented in other courses) into a working software application. Prerequisite(s): [(MSF 504 and MSF 505)]

(3-0-3)

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. Pre-requisites: MSF 501, 502, 503, 504, 505, 506

 $\begin{array}{l} \mbox{Prerequisite(s): } [(\mbox{MSF 504 and MSF 505})] \\ (3-0-3) \end{array}$

MSF 584

Equity & 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: MSF 504

Prerequisite(s): [(MSF 504 and MSF 505)] (3-0-3)

MSF 585

FOREX & Fixed Income Strategies

This course will present basic trading concepts related to fixed income instruments. Also covered will be the analysis of repos and fixed income derivatives such as forwards and futures, options, and spreads. Trading strategies will be discussed including yield curve strategies, basis trading, and various types of spread trading using many different instrument types. Students will make trading decisions and modify their portfolios in order to familiarize themselves with the instruments and techniques introduced. Swaps, swaptions, caps, and floors may be introduced. (3-0-3)

MSF 591

Global Financial Markets

This course will enable the student to understand the basics of financial markets and how they function in the global arena. The student will learn how the equities market, the bond market, the money market, the foreign exchange market and the derivatives markets are set up and operate. We will focus on the instruments, the players, the jargon, the details of the trade, and the institutional framework for each market. We cover both OTC and exchange-traded markets, and explore the dramatic transformation of these markets. The student will learn how each of these markets operates in the US, but will also learn how practices differ in Europe, Asia and Latin America.

Prerequisite(s): [(MSF 504 and MSF 505)] (3-0-3)

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: MSF 501. Prerequisite(s): [(MSF 504 and MSF 505)] (3-0-3)

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. Prerequisites: MSF 501, 502, 503, 504, 505, 506, 507

Prerequisite(s): [(MSF 504, MSF 505, and MSF 506)] (3-0-3)

MSF 596

Research Seminar in Finance

The primary focus of this advanced seminar course is on the analysis of credit risk in the financial industry. Credit risk management will cover both corporate banking and investment banking. The course will also review industry applications of credit risk methodology through a review of technical documents and research papers. The course will discuss important and timely classes of credit risk models, e.g., Metron's structural form, reduced form, actuarial, and scoring, in addition to rating techniques provided by the rating agencies. In addition, regulatory guidance and banks' own development in internal ratings systems and credit risk models (expected loss, unexpected loss, default correlation, and loss distributions: will be examined in depth. Students are expected to present recent research and classic papers in the field.

Prerequisite(s): [(ACCT 501) OR (MSF 532)] AND [(MSF 521 and MSF 551)] (3-0-3)

MSF 597

Independent Study in Finance Independent study.

(Credit: Variable)

MSF 598

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.

 $\ensuremath{\mathsf{Prerequisite}}(s) \colon [(\ensuremath{\mathsf{MSF}}\xspace{505}, \ensuremath{\mathsf{and}}\xspace{\mathsf{MSF}}\xspace{506})] \ensuremath{(3-3-3)}$

MSF 599

Special Topics - MSF Program Special topics. (3-0-3)

Professional Communication Advancement

PCA 500

Professional Communication

Professional communication. (3-0-3)

PCA 510

Communication Essentials

This course will prepare students to communicate effectively with native speakers in a variety of settings by teaching language strategies, phrases, linguistic structures, and vocabulary in English. The course will focus on initiating, maintaining, and ending basic conversations. Understanding cultural context and responding appropriately will be emphasized. Prerequisite: Department approval only; determined by assessments.

(1.5-0-1.5)

PCA 515

Strategies for Effective Communication

Students will incorporate subject material learned in PCA 510 and use the knowledge gained to develop higher communicative fluency in order to discuss topics with more competency. This course will focus on developing students' ability to build and sustain communication across a variety of settings with an emphasis on asking for and providing information, expressing feelings, asking for and giving advice, and asking for and giving opinions. Prerequisite: Department approval only; determined by assessments. (1.5-0-1.5)

PCA 520

Advanced Communication Skills

Students in this course will learn higher-level communication strategies necessary to communicate in various settings and for a wide range of purposes – academic, business, and social. Students will learn language and cultural strategies for effectively working as a team. Prerequisite: Department approval only; determined by assessments. (1.5-0-1.5)

PCA 525

Advanced Presentation Skills

Students will incorporate course material learned in PCA 520 to practice speaking and presenting on a wide variety of topics including subject matter currently being learned and discussed in their business classes. By the end, students will present complex and detailed presentations working on sophisticated vocabulary and advanced communication skills. Prerequisite: Department approval only; determined by assessments.

(1.5-0-1.5)

PCA 527

Foundations of Academic Writing

Students will learn to write effective, organized, and coherent paragraphs and a variety of writing assignments following the deductive organizational structure used in academic English. Students will learn how to use standard academic vocabulary and appropriate word forms to express their ideas effectively in writing. The following topics will be taught in the course: vocabulary expansion; editing skills; unity and coherence in writing; and paragraph structure. Prerequisite: Department approval only; determined by assessments. (1.5-0-1.5)

PCA 530

Academic Writing I

Students will learn to write effective, organized, and coherent academic paragraphs and essays in English. Students will learn and practice ways to express themselves clearly in writing. The following topics will be taught: brainstorming and planning; topic sentences and thesis statements; transitional words and phrases; the American organization style; grammar; proofreading; and editing. Prerequisite: Department approval only; determined by assessments. (1.5-0-1.5)

PCA 540

Academic Writing II

In this course, students will build on paragraph development to write essays with greater complexity and logical organization of outside support. Students will learn to develop critical and analytical skills through the essay writing process using proper reference and citation techniques. This course includes a review and refinement of English grammar to produce clear, concise, and polished academic writing. Prerequisite: Department approval only; determined by assessments. (1.5-0-1.5)

PCA 550

Business Writing

Students in this course will learn the higher-level business writing tasks and writing skills needed to effectively communicate using various business formats.Students will learn and practice appropriate language structures, phrases, and vocabulary commonly used in American business writing. Prerequisite: Department approval only; determined by assessments. (1.5-0-1.5)

PCA 560

Prof Commn Adv - Presentation

Presentation. (1.5-0-1.5)

PCA 570

Pronunciation

1.5 credit hours. Students will learn pronunciation strategies to communicate more effectively with others in English. There are many individual components necessary for good English pronunciation including vowel and consonant sounds, word stress and rhythm, sounds in connected speech, and intonation. Students will learn what these components are and be taught strategies for using them in their everyday communication. Students will be responsible for practicing these strategies in and out of class. Prerequisite: Department approval only, determined by assessments. (1.5-0-1.5)

PCA 594

Professional Communication Advancement Independent Study Full or half-semester course. Independent study to meet the special English communication needs of Stuart graduate students. Subject matter will vary with the backgrounds and skill levels of students. Requires written consent of the instructor.

Public Administration

PA 501

Essentials for Public Management in a Complex Society: Processes, Structures, & Values

This course provides an understanding of the fundamental theories, key practices and underlying values 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. (3-0-3)

PA 502

Leading & Managing Knowledge Intensive Organizations

PA 502 builds awareness and understanding of the behavior of individuals and groups in organizations, preparing managers to be more effective within their organizational contexts. Topics include individual differences in motivation, perception, culture and learning style: group and organizational dynamics; and the impact of organizational structure and culture on behavior. Leadership techniques for influencing $other \ \ organizational \ \ members, \ \ creative \ \ problem-solving$ and decision-making, ethics and values-based managing are covered. This course helps students relate basic theories, concepts, and techniques to real-world situations through the extensive use of case studies.

Prerequisite(s): [(PA 501*)] An asterisk (*) designates a course which may be taken concurrently.

(3-0-3)

PA 503

Administrative Law

Considers the role of statutes, case law and administrative law in the establishment, operation and control of public agencies. Examines how legislation and administrative procedures direct and constrain the exercise of discretion by public managers and how they ensure accountability and the fair treatment of the public.

Prerequisite(s): [(PA 501*)] An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

PA 505

The Law & the Nonprofit Sector

This course is an examination of the law, local, state, and Federal as it pertains to the nonprofit sector. This includes such things as the IRS, lobbying, human resources, property, and contracts.

Prerequisite(s): [(PA 501*)] An asterisk (*) designates a course which may be taken concurrently.

(3-0-3)

PA 506

Managerial Economics

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. (3-0-3)

PA 507

Contemporary Issues in International Business

To operate in the complex environment of a globalized world, managers must develop an in-depth understanding of current events. The international business professional must develop an appreciation for topics such as the OPEC oil cartel, international risk analysis, technological advances as a driver of global markets, major international strategies, crosscultural competence, the political economy of modernization, collaborative ventures, and international acquisitions. The course also provides rigorous economic analysis of the modern theory of trade as well as government trade policies. It deals with the factors that determine the exchange rate systems. Furthermore, the course analyzes the crises in emerging markets and the need to revamp the international financial system. In the areas of trade, topics covered include: the Doha round, economic integration (i.e. the EU, free trade areas), and the meteoric rise of sovereign wealth funds (SWF). (3-0-3)

PA 509

Integrative Practicum for Effective Leadership in Public & Nonprofit Organizations

PA 509 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 509 should be taken in the student's last semester.

Prerequisite(s): [(PA 580*)] An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

PA 510

Managerial Communications

Provides hands-on training and practice in the styles of writing and related communications skills needed by all public managers, including memoranda, letters, and formal reports. Emphasis is placed on learning and practicing effective writing and communication related to real-world administrative and managerial situations relevant to the student's particular current or chosen professional position.

Prerequisite(s): [(PA 501*)] An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

PA 511

Comparative Public Administration

An introduction to comparative analysis of systems of public administration in selected nations, including Great Britain, Japan, China, and major non-governmental organizations such as the European Union and the United Nations. The nations and organizations discussed will be compared to each other and to the United States. Areas explored will include: the historical antecedents of current national administrative systems (including the development of the nation-state), public administration models and structure in both developed and developing nations, the relationship between bureaucracies and political systems, the rise of the international nongovernmental organization, and the impact of corruption on public administration. (3-0-3)

Prerequisite(s): [(PA 501*)] An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

PA 512 Public Advocacy

The goal of this course is to assist students function 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: 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. (3-0-3)

PA 514

Government Management & Information Systems

A practical introduction to database management programs. Demonstrates the use of a variety of other office automation software tools (including graphics, desktop publishing, telecommunications/file transfer, bibliographic text retrieval, computer-aided instruction, and expert systems). Considers issues relating to effective computer management, including computer ethics, security, needs assessment and training. Prior working knowledge of personal computer operating systems, word processing, and spreadsheet programs is needed.

Prerequisite(s): $[(PA 501^*)]$ An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

PA 516

Information Technology in Publc Administration

The course has the learning objective of becoming aware of the general management challenges that the use of information technology presents for governments and to be able to develop appropriate policies that address these challenges. Upon completion, students should be able to apply best practices to the management of computer hardware, software, networking, and other technologies in government and appreciate how the use of electronic government technology can transform government and be able to help governments develop and manage effective programs of e-government use.

Prerequisite(s): [(PA 501*)] An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

PA 522

Effective Management of Human Resources in Environments of Scarce Resources

This course focuses on human resource planning, recruitment, examination and promotion of procedure. It familiarizes students with the key human resources management factors involved in supervising employees, as well as collective bargaining, affirmative action, and employee productivity and performance evaluation. It is directed towards practical applications in dealing with these topics as managers and employees working in their teams or individually and covers employee professional responsibility and behavior. Students in this class will learn to utilize human resource planning, recruiting, interviewing and selection processes to improve organizational outcomes; analyze the legal/cultural aspects of personnel when making organizational decisions; identify the key components of performance management to improve themselves and their direct reports; develop specific solutions to solve critical workplace personnel issues; and apply a variety of motivation and team performance techniques in current and future organizational settings .

 $\label{eq:precession} Prerequisite(s): \quad [(PA \ 501^*)] \ An \ asterisk \ (*) \ designates \ a \\ course which may be taken concurrently.$

(3-0-3)

PA 532

Managing Public Financial Resources in a Changing World

Managing Public Financial Resources in a Changing World exposes students to fundamental concepts and strategies of public financial resource management in a rapidly changing fiscal environment. It provides students with the concepts and skills needed to evaluate budget processes and documents, understand the role of politics and planning in financial management and to evaluate the financial condition of governments. Emphasizing best practice models and case studies, the course will focus primarily on local government finance with some reference to state government policies and practices. Some reference also will be made to nonprofit budgeting accounting practices.

Prerequisite(s): $[(PA 501^*)]$ An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

PA 533

Advanced Financial Management for Public & Nonprofit Sectors

An advanced course focusing on the application of techniques used by financial managers to evaluate government financial condition and performance. Students will conduct case studies in which they apply tools such as performance measurement, budget analysis, priority setting and financial indicator analysis to evaluate core public financial documents including budgets, capital improvement plans and audited financial statements.

Prerequisite(s): $[(PA 532^*)]$ An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

PA 534

Financial Management in the Nonprofit Sector

Nonprofits are business organized on many of the same principle as for-profits, but there are differences including financial reporting to boards of directors, donation accounting, reporting to government funding sources, tax reporting, and even investment strategies (for example program related investing). This course will equip a nonprofit manager to responsibly guide the complex financial life of a modern nonprofit.

Prerequisite(s): [(PA 532)] (3-0-3)

PA 535

Resource Development in the Nonprofit Sector

Resource Development in the Nonprofit Sector provides insight and learning into fundraising, marketing, and strategic planning in the nonprofit sector. This course offers an in-depth look into finding and securing the resources necessary to the success of nonprofit organizations.

Prerequisite(s): $[(PA 501^*)]$ An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

Strategy & Structure: Homeland Security

This course introduces the student to the National Strategy for Homeland Security and describes the structure under which it was originally designed, the events that have affected the original concept and the various changes that is has undergone since the events of 09/11/2001. The student will become intimately acquainted with the key legal parameters affecting HS and the government components involved in HS operations, enforcement and intelligence. An emphasis on the overall integration of state, local, tribal and private sectors will enable the student to apply the tenets of HS to their own individual situations. Other topics will include an understanding of how to conduct Threat Assessments as well as a cursory understanding of the Intelligence Cycle.

Prerequisite(s): [(PA 501^{*})] An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

PA 537

Crisis Management/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 audience issues related to homeland security, awareness on the types of threats (damage to building processing plants, public facilities, etc.) and the type of risks involved. Other relevant aspects include types of weapons used by modern terrorists; how one goes about estimating risk and threat to a facility; how buildings and people respond when subjected to blast and fires; the role of search and rescue operation; weapon effect; building security; facility analysis to identify vulnerable areas given a threat; procedures for minimizing vulnerability; effective fire safety; contingency plans, etc. At the conclusion of this course the student will know how to estimate the risk and threat to a given facility, prepare a basic security audit; develop a basic contingency plan, develop passive/active security system for a given facility and develop post event search and rescue operations.

Prerequisite(s): $[(PA 501^*)]$ An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

PA 538

Information Systems Security/Cyber Crime

Provides an introduction to information systems security, an in-depth review of topics in cyber-crime issues in the public safety field and identifies methods of preventing cyber-crime in organizations. It includes issues involved with policy and legal issues of enforcement of cyber-crime laws, as well as tools used for network security.

Prerequisite(s): $[(PA 501^*)]$ An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

(0-0-0)

PA 539

Local Government Management

This course examines the governmental structure in which public safety administrators work and studies the interrelationship of public safety administrators with the rest of the organization. The leadership and management roles of public safety officials, finances & budgeting in local government, and ethics in the profession will be examined. Prerequisite(s): $[(PA 501^*)]$ An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

PA 540

Public Sector 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 (3-0-3)

PA 541

Performance Measurement in Nonprofit & 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 non-profit and government leaders and staff plan and manage the programs and services they offer to customers, clients and the public. This is an applied course which will help students understand performance management concepts, develop specific performance measures, and apply performance management techniques to solve real world problems in both the nonprofit and public sectors.

Prerequisite(s): $[(PA 501^*)]$ An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

PA 543

Public Policy Nonprofits & 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 of philanthropy has played in the development of modern public policy, as it pertains to health and human services.

Prerequisite(s): $[(PA 501^*)]$ An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

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, 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 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. (3-0-3)

Public Infrastructure Management

Considers the status and operation of public infrastructure facilities in the United States generally and in the Chicago metropolitan area, with particular attention to the responsibilities and roles of the public works manager. Explores the relationship between the engineering, administrative and political aspects of public works management. Focuses on critical infrastructure issues through case studies.

Prerequisite(s): $[(PA 501^*)]$ An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

PA 552

Human Services Policy & Administration

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. 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.

(3-0-3)

PA 553

Public Safety Administration

Deals with contemporary public safety and security management in communities for public safety professionals, public administrators and law enforcement officials who deal with public safety issues, existing in post-9/11 American society. Examines the relationship between police/public safety policy, operations and administration. Addresses various current problems and issues through case studies. Focuses mainly on the City of Chicago and surrounding metropolitan area.

Prerequisite(s): $[(PA 501^*)]$ An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

PA 555

Introduction to Urban & Regional Planning

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, demographic and economic analysis. They will also learn about various processes providing participation and citizen input to the development of plans for the built environment. Regulatory tools covered include zoning, comprehensive plans, neighborhood planning and subdivision regulation.

Prerequisite(s): $[(PA 501^*)]$ An asterisk (*) designates a course which may be taken concurrently.

(3-0-3)

PA 556

Public Management Strategies for the 21st Century

In the United States, an increasing proportion of the goods and services traditionally provided by governmental employees in the context of a governmental bureaucracy are now provided by outside contractors, or through indirect means such as social, economic regulation, tax policy, loan guarantees, vouchers, and manipulation of incentives for the private sector. This course is intended to provide students with an understanding of various tools used by governments throughout the West as the traditional rule based bureaucracy is replaced by other types of institutions and other means to provide goods and services traditionally provided by government.

Prerequisite(s): $[(PA 501^*)]$ An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

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PA 557 Urban & Regional Development

This course covers materials on infrastructure management,

and the interrelationship of infrastructure management to urban and regional development. The course acquaints students with the increasing role of the private sector in infrastructure maintenance, development, and management. Students learn various analytic techniques useful for officials responsible for urban and regional development (including development of new infrastructure) and for the continuing maintenance and management of existing infrastructure. Students learn analytic techniques relating to management and planning.

Prerequisite(s): $[(PA 501^*)]$ An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

PA 558

Energy & Environmental Policy

Successful completion of at least one other course marked with an and satisfaction of IIT's Basic Writing Proficiency Requirement. Places energy and environmental policy in domestic and global contexts. Traces the economic and political implications of dependence on fossil fuels and the attempt to develop alternate energy sources and promote conservation. Assesses the environmental effects of resource consumption and the effort to control these effects by increased efficiency and regulation of pollution. Explores such problems such as nuclear waste, acid rain, global warming, and deforestation. Examines national and international attempts at economic, political, and technological solutions. Prerequisite(s): [(PA 501*)] An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

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, sociopolitical, and cultural aspects of globalization within the context of contemporary debates about the phenomenon. Prerequisite(s): $[(PA 501^*)]$ An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

Political Economy

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, impact of economic ideologies on political and economic systems will be examined. Structure of political and economic interests and the mediating effects of institutions on political and economic outcomes will be examined. Normative issues connected to ideal political and economic institutions and appropriate political and economic institutions and outcomes will be examined. The impact of the political and economic institutions on the problems of public administration at both the national and state level will be covered as well as the appropriate role for administrators, elected officials and private sector leaders in the formulation of political and economic policy.

Prerequisite(s): $[(PA 501^*)]$ An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

PA 561

The Political Process & Administration

Addresses the relation between democratic institutions and processes of American politics and the administrative agencies of government. Examines obligations of citizenship, influence of private interests—especially economic—on public purposes, and effects of demographic, economic and technological change on self-government.

Prerequisite(s): $[(PA 501^*)]$ An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

PA 562

Urban & Metropolitan Government

Analyzes the decision-making process in urban and metropolitan governments. Emphasizes the role of elected and appointed officials, business, organized labor, community organizations and the electorate. Also focuses on the major problems of city-suburban relations.

Prerequisite(s): $[(PA 501^*)]$ An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

PA 565

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 privatepublic connections.

Prerequisite(s): $[(PA 501^*)]$ An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

PA 566

Nonprofits & the Public Sector

Nonprofits and the Public Sector, 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 grand and contract funding, recent trends, and much more.

Prerequisite(s): $[(PA 501^*)]$ An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

PA 567

Regulatory Policy & Politics

Examines the changing role of government regulation of private and public activities from a political and administrative perspective. Explores the reasons for growth and reform of economic and social regulation. Investigates the regulatory process, including standards for rule-making and the involvement of organized groups and the courts.

Prerequisite(s): $[(PA \ 501^*)]$ An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

PA 568

Strategic Competiteveness 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 films' strategic decisions regarding investment and trade? How can public leaders enhance the competitiveness of their business environment by adopting entrepreneurial government strategies? What are best practices for economic development in the Next Economy?

Prerequisite(s): [(PA 501*)] An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

PA 570

Social Capital & 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 its economic life. Using an Asset Based Community Development Approach the objective of this course is to help the student understand and use the concepts of asset based approaches to social capital and community as it relates to public administration. Prerequisite(s): [(PA 501*)] An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

PA 577

Topics in Public Management

A reading and seminar course on a contemporary topic in public administration or policy. Subject matter will change in successive offerings of the course. (Credit: Variable) Prerequisite(s): [(PA 501*)] An asterisk (*) designates a course which may be taken concurrently. (Credit: Variable)

Planning, Policy Making, & 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. (3-0-3)

(0-0-0)

PA 579

Ethics & Professional Responsibility in Public Service

Focuses on the ethical problems and issues faced by individuals in public service organizations. Examines questions related to corruption, abuse of power, financial impropriety, ethics codes and standards in government and professional fields, whistle-blowing, and many other topics related to front-page concerns and individual problems of conscience and judgment. Traces the growth of concern about the standards of ethical behavior in government in U.S.

Prerequisite(s): [(PA 501*)] An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

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 policymakers 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 policymakers and staff to focus budgets and efforts to best achieve policy or program goals.

(3-0-3)

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. Includes 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)]

(3-0-3)

PA 588

Incident Response Disaster Recovery & Business Continuity

Students learn to design and manage key business information security functions including incident response plans and incident response teams; disaster recovery plans; business continuity plans; and crisis management teams and plans. Reporting, response planning and budgeting are all addressed. Students working in teams will prepare an incident response, disaster recovery, business continuity, or crisis management plan for a real world organization such as a business or a government body or agency.

Prerequisite(s): $[(PA 501^*)]$ An asterisk (*) designates a course which may be taken concurrently.

(3-0-3)

PA 590

Internship in Public Administration

Supervised practical experience in public administration. May be taken only be students lacking extensive work experience in governmental administration. (credit: variable) Prerequisite(s): [(PA 501)] (Credit: Variable)

PA 592

Directed Readings in PA

Consists of independent reading and analysis centered on particular problems and supervised by a member of the public administration faculty. (Credit: Variable) (Credit: Variable)

PA 597

Special Problems

Subject matter will vary with the interests and the background of the students and the instructor. May be taken more than once. (Credit: Maximum of six hours) Prerequisite: Instructor permission required. (3-0-3)

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PA 600

Continuation of Residence Continuation of residence. (0-0-1)

Stuart School of Business

SSB 510

ACE Seminar

The two-semester Advancing Career and Education is a graduation requirement that complements the graduate business student's academic experience and prepares the student for professional internship placement and the postgraduation job market. The first semester course (SSB 510) explores personal development topics communication skills, acculturation, competitive job search skills, and selfawareness. This course also builds skills and self-awareness. This course also builds an awareness related to the workplace including resume development, communication, workplace etiquette, presentation skills, teamwork and motivation, and workplace relationships. During the first semester students are assigned to a partner organization where they will begin completion of the 100 project hours required at the end of their second semester in the program. (0-0-0)

SSB 511

Advancing Career & Education II

The two-semester Advancing Career and Education seminar 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. The second semester course (SSB 511) focuses on internship search and interviewing skills including how to leverage relational or ?soft? skills, internship strategies and tools, networking and informational interviewing, and employer expectations. Additional topics covered include workplace themes such as organizational structure, personal influence, and conflict negotiation. Students must complete 100 project hours at their partner organization by the end of the semester in order to pass the course. (0-0-0)

SSB 520

Service Learning-Semester II Service learning. (0-0-0)

Department of Chemical and Biological Engineering

127 Perlstein Hall 10 W. 33rd St. Chicago, IL 60616 312.567.3040 312.567.8874 fax chbe@iit.edu www.chbe.iit.edu

Interim Chair:

Satish Parulekar

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

Degrees Offered

Master of Biological Engineering Master of Chemical Engineering Master of Science in Chemical Engineering Doctor of Philosophy in Chemical Engineering

Certificate Programs

Biological Engineering Current Energy Issues Food Process Engineering Food Processing Specialist Polymer Science and Engineering

Interdisciplinary Programs

Energy/Environment/Economics (E³) specialization

this mission, the department provides graduate students with:

- Fundamental knowledge and design capability in biological engineering, chemical engineering, and food process 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.

Master of Science in Food Process Engineering

With the Institute for Food Safety and Health:

• Lifelong learning capabilities.

Master of Food Process Engineering

Research Centers and Institutes

Center for Electrochemical Science and Engineering: Jai Prakash, Director

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

Engineering Center for Diabetes Research and Education: Ali Cinar, Director

Research Facilities

Research facilities of the department include: **Biochemical Engineering Lab Biointerfaces** Lab **Biomaterials Lab** Center for Electrochemical Science and Engineering Lab Center of Excellence in Polymer Science and Engineering Lab Computational Fluid Dynamics Lab Fuel Cell Lab Fuel Cell Battery Lab Fluidization Lab Gas Processing Lab Interfacial Phenomena Lab Light Scattering Lab Multiphase Flow and Fluidization Lab Particle Technology Lab Polymer Characterization Lab Polymer Reaction Engineering Lab Porous Media and Core Analysis Lab

Research Areas

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

Energy and Sustainability

Fuel Cells Fluidization and Gasification Hybrid Systems

Biological Engineering

Molecular Modeling Diabetes Biomedical and Pharmaceutical Engineering Biochemical Engineering Food Processing Center for Molecular Study of Condensed Soft Matter: Jay Schieber, Director

Center for Complex Systems and Dynamics: Fouad Teymour, Director

Wanger Institute for Sustainable Energy Research: Hamid Arastapoor, Director

> Process Control & Optimization Lab Process Modeling, Monitoring and Control Lab Rheology Lab Riser Lab Hydrogen Storage Lab

The computational facilities of the department include the Advanced Computer Laboratory, and the computer facilities of each research group. There are 26 Pentiumbased computers in the PC lab that can access the workstations, creating a 26-seat computational lab for instructional activities at the graduate and undergraduate levels. All computers are connected to the IIT 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.

Advanced Materials

Interfacial and Transport Phenomena Nanotechnology Polymers Biomaterials

Systems Engineering

Complex Systems Advanced Process Control Process Monitoring

Faculty

Abbasian, Javad, Associate Professor of Chemical Engineering. B.S., Abadan Institute of Technology (Iran); M.B.A., University of Chicago; M.S., Ph.D., Illinois Institute of Technology. High temperature gas cleaning, pollution control and solid waste management; gas separation and purification; and process design and development.

Aderangi, Nader, Senior Lecturer of Chemical Engineering and Director of the Undergraduate Laboratories. B.S., University of Tehran (Iran); M.S., University of Colorado; Ph.D., Illinois Institute of Technology.

Anderson, John L., Professor of Chemical Engineering and President of the Illinois Institute of Technology.B.S., University of Delaware; Ph.D., University of Illinois, Urbana-Champaign.

Arastoopour, Hamid, Professor of Chemical Engineering and Mechanical Engineering, Henry R. Linden Professor of Engineering, and Director of the Wanger Institute for Sustainability and Energy Research (WISER). B.S., Abadan Institute of Technology (Iran); M.S., Ph.D., G.E., Illinois Institute of Technology. Computational fluid dynamics (CFD), multiphase flow, fluidization, flow in porous media, particle technology and material processing, and environmental engineering problems, hydrogen storage, tire recycling, particle technology in applications to coal gasification, production of gas from unconventional gas reserves and hydrates, and energy sustainability issues..

Chmielewski, Donald J., Associate Professor of Chemical Engineering. B.S., Illinois Institute of Technology; M.S., Ph.D., University of CaliforniaLos Angeles. Advanced process control; fuel cell system design and control.

Cinar, Ali, Professor of Chemical Engineering and Biomedical Engineering, Vice Provost for Research, Dean of the Graduate College, and Director of Engineering Center for Diabetes Research and Education. B.S., Robert College (Turkey); M.Eng., Ph.D., Texas A&M University. Agent-based systems for process modeling, supervision, and control; modeling of angiogenesis and tissue growth; diabetes and control of insulin pumps; supervision and control of biological and chemical processes, complexity, AI applications, modeling and simulation of biomedical systems.

Gidaspow, Dimitri, Professor Emeritus. B.S., City College of New York; M.S., Polytechnic Institute of Brooklyn; Ph.D., Illinois Institute of Technology. Research interests: Hydrodynamic theories of fluidization and multiphase flow, gas-solid transport, and hydrodynamic models for slurry bubble column reactors.

Indei, Tsutomu, Visiting Assistant Professor of Chemical Engineering. B.S., M.S., Ph.D., University of Tsukuba (Japan). Karuri, Nancy W., Assistant Professor of Chemical Engineering. B.Eng., University of New South Wales (Australia); Ph.D., University of Wisconsin-Madison. Tissue engineering, biomimetic scaffolds, extracellular matrix assembly.

Krishnamurthy, Kathiravan, Research Assistant Professor of Chemical Engineering. B.E., Tamil Nadu Agricultural University (India); M.S.,Ph.D., Pennsylvania State University. Food engineering, novel and emerging food processing technologies, simulation and modeling of food processes, food safety, thermal processing technologies.

Nikolov, Alexander, Research Professor of Chemical Engineering. B.S., Ph.D., University of Sofia (Bulgaria).

Parulekar, Satish, Professor of Chemical Engineering and Interim Chair of the Department. B.Ch.E., University of Bombay (India); M.S., University of Pittsburgh; Ph.D., Purdue University. Biochemical engineering, chemical reaction engineering, modeling and optimization of biological and chemical processes, reactions with separations, food processing for bacterial inactivation, biofuel synthesis.

Pérez-Luna, Victor H., Associate Professor of Chemical Engineering. B.S., M.S. Universidad de Guadalajara (Mexico); Ph.D., University of Washington. Surface analysis and modification, biomaterials and biosensors, and tissue engineering.

Prakash, Jai, Professor of Chemical Engineering and Director of the Center for Electrochemical Science and Engineering. B.S., M.S., Ph.D., University of Delhi (India); Ph.D., Case Western Reserve University. Electrochemistry, materials development, and batteries and fuel cells.

Ramani, Vijay K., Hyosung S.R. Cho Associate Professor of Chemical Engineering. B.E. Annamalai University (India); Ph.D., University of Connecticut. Hybrid materials for sustainable chemical and electrochemical energy conversion, hydrogen and liquid fueled polymer electrolyte fuel cells (PEFCs), degradation mitigation strategies in PEFCs, and development of educational modules to demonstrate sustainable energy economy concepts.

Schieber, Jay D., Professor of Chemical Engineering and Physics and Director of the Center for the Molecular Study of Condensed Soft Matter. Ph.D., University of Wisconsin-Madison. Experiment, theory, and computation in the multiscale study of soft matter, including both biological and synthetic materials.

Segovia, Javier, Visiting Professor of Chemical Engineering. M.S., Complutense University of Madrid (Spain); Ph.D., Technical University of Madrid (Spain). Teymour, Fouad A., S.C. Johnson Polymer Professor of Chemical Engineering and Director of the Center of Complex Systems and Dynamics. B.Sc., M.Sc., Cairo University (Egypt); Ph.D., University of Wisconsin-Madison. Polymer reaction engineering, mathematical modeling, nonlinear dynamics, and complexity and complex systems.

Venerus, David C., Professor of Chemical Engineering and Director of the Center of Excellence in Polymer Science and Engineering. B.S., University of Rhode Island; M.S., Ph.D., Pennsylvania State University. Transport phenomena in complex materials, forced Rayleigh scattering, polymer rheology, and polymer foam processing. Wasan, Darsh T., Distinguished Motorola Professor of Chemical Engineering and Vice President for International Affairs, . B.S., University of Illinois, Urbana-Champaign; Ph.D., University of California-Berkeley. Thin liquid films, foams, emulsions and nanoparticle suspensions, film rheology and applications, wetting, spreading and adhesion of nano-fluids on solid surfaces, environmental technologies, food colloids.

Research Faculty

Aderangi, Nader, Lecturer in Chemical Engineering and Director of Undergaduate Department Laboratories. B.S., University of Tehran; M.S., University of Colorado; Ph.D., Illinois Institute of Technology. Research interests: Unit operations, chemical processes, interfacial mass transfer, rheological properties.

Nikolov, Alex, Research Professor of Chemical Engineering. B.S., Ph.D., University of Sofia (Bulgaria). Research interests: Interfacial rheology, foams, emulsion, dispersion, and thin liquid films.

Plomp, Bert, Research Professor of Chemical Engineering and Project Manager Supercapacitors, Energy Research Centre of the Netherlands ECN. Ing. Electrical Engineering and Information Technology, Ir. Applied Physics Delft University of Technology (Netherlands); Dr. Physical Chemistry, Free University of Amsterdam (Netherlands). Research interests: Fuel cells and supercapacitors.

Adjunct Faculty

Anderson, Robert, Master of Management, Northwestern University. .

Selman, J. Robert, IIT Distinguished Research Professor of Chemical Engineering. Ing., Technical University (Netherlands); M.S., University of Wisconsin-Madison; Ph.D., University of California, Berkeley. Research interests: Fuel cell and battery design and operation; high-temperature fuel cells; lithium battery design and thermal management.

Sun, Yang-Kook, Research Professor of Chemical Engineering. M.S., Ph.D. Seoul National University. Research interests: Lithium batteries, hybrid electrochemical capacitors with high power and high capacitor, solid oxide fuel cell.

Admission Requirements

Cumulative Undergraduate GPA: 3.0/4.0 GRE score minimum:

- 1. MAS 950 (quantitative + verbal),
- 2.5 (analytical writing)
- After August 2011 MAS 295 (quantitative + verbal), 2.5 (analytical writing)
- M.S./Ph.D.: 1100 (quantitative + verbal), 3.0 (analytical writing)
- 2. After August 2011 M.S./Ph.D.: 304 (quantitative + verbal), 3.0 (analytical writing)

TOEFL minimum score: 550/213/80*

Note: The GRE requirement is waived for Professional Master's degree applicants who hold a Bachelor of Science in a related field from an ABET-accredited university in the United States, with a minimum cumulative GPA of 3.0/4.0

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

Meeting the minimum GPA and test score requirements does not guarantee admission. Test scores and GPA are just two of several important factors considered. Admission to graduate study in chemical engineering or biological engineering, 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, additional 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. Admission to graduate degree programs in food process engineering normally requires a bachelor's degree in chemistry; biology; food science; chemical, agricultural, food, or environmental engineering; or a related field. Depending on the student's background, additional deficiency courses, some of which may not count toward the degree, may be required. Please see the department's list of applicable undergraduate courses.

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

Master of Biological Engineering

30 credit hours

No Thesis Requirement

The objective of this degree program is to prepare students for professional practice in any field of engineering involving heavy emphasis on biological processes, and to provide a foundation in the fundamental knowledge of biological engineering. The student must have a minimum grade point average of 3.0/4.0 in the core areas. Candidates are required to take a total of 30 credits, 9 credits for core courses, 7 credits of required biology courses, 2 credits of a required professional course, and 12 credits of electives chosen from the list below.

Core Courses

CHE 406 Transport Phenomena

CHE 503 Thermodynamics

CHE 577 Bioprocess Engineering

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

Biology Requirements

BIOL 504 Biochemistry Lectures

BIOL 515 Molecular Biology (after completing BIOL 504)

Master of Chemical Engineering

30 credit hours No Thesis Requirement 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. The student must have a minimum grade point average of 3.0/4.0 in the core areas. Candidates are required to take a total of 30 credits, 12 credits for core courses, 2 credits of a required professional course, and 16 credits of electives. Elective courses are to be determined in consultation with academic advisor.

Professional Requirement

CHE 506 Entrepreneurship and Intellectual Property Management

Electives

- BME 525 Concepts of Tissue Engineering
- BME 533 Biostatistics BME 570 Engineering Biocompatible Materials
- CHE 545 Metabolic Engineering
- THE 545 Metabolic Engineer
- CHE 580 Biomaterials

CHE 583 Pharmaceutical Engineering

- CHE 584 Tissue Engineering
- CHE 585 Drug Delivery
- CHE 597 Research Project
- ENVE 513 Biotechnological Processes in Environmental Engineering
- Any 500 level Food Process Engineering course

Other approved electives from CHE, CHEM, BME, BIOL

Core Courses

CHE 406 Transport Phenomena CHE 503 Thermodynamics CHE 525 Chemical Reaction Engineering*

AND one of the following:

CHE 535 Applications of Mathematics to Engineering CHE 530 Advanced Process Control

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

*Note: Interested students can substitute, upon advisor consent, CHE 577: Bioprocess Engineering for CHE 525: Chemical Reaction Engineering.

Professional Requirement

CHE 506 Intellectual Property Management and Entrepreneurship

Master of Food Process Engineering

Through the Institute for Food Safety and Health

32 credit hours Professional Non-Thesis

Program Description

The Food Process Engineering (FPE) programs at IFSH are directed toward students with background and career objectives in engineering related disciplines. GPA and test scores are just two of the several important factors considered. Admission to graduate study in food process engineering generally requires a bachelor's degree in chemical, agricultural, food, or environmental engineering; food science; chemistry; biology; or a related field. Depending on the student's background, additional proficiency courses, some of which may not count toward the degree, may be required. See the department's list of applicable undergraduate courses. Students in the Food Process Engineering programs should consult with their IFSH, IIT faculty advisor to plan a program of study best suited to their background and interests. Candidates are required to take a total of 32 credit hours, 15-18 of which must be from the core courses listed below, 8-11 credit hours must be selected from elective courses, and 5-6 credit hours must be selected from the Chemical and Biological Engineering Department Courses. Courses are offered via internet with the exception of FPE 506, FPE 593, FPE 594, and FPE 597.

Core Course Requirements

- FPE 505 Food Microbiology
- FPE 506 Food Microbiology Laboratory*
- FPE 521 Food Process Engineering
- FPE 522 Advanced Food Process Engineering
- FPE 524 Fundamentals of Food Science and Technology
- FPE 541 Principles of Food Packaging

* FPE 506 is required unless the student has enough professional experience to allow a substitute class, the decision will be made by the IFSH Program Director.

Proficiency Requirement

These courses may be required if the student has not taken an equivalent course at the undergraduate level:

- CHE 406 Transport Phenomena
- CHE 423 Chemical Reaction Engineering
- CHE 435 Process Control

The student must have a minimum grade point average of 3.0/4.0 in the core courses. In addition to the core courses, coursework may be selected (with IFSH advisor approval) to satisfy the needs of the individual student or may be concentrated in one of the following areas of specialization:

- Process and product development
- Food processing operations
- Food packaging
- Food safety
- Food biotechnology
- Process and quality monitoring and control

Required courses for these specializations are described in the course descriptions.

FPE Electives (8-11 credit hours)

Students must take at least two of the following:

- FPE 501 Nutrition, Metabolism and Health
- FST 502 Research Project: Design, Delivery and Dissemination
- FPE 504 Food Biotechnology
- FPE 507 Food Analysis
- FPE 511 $\,$ Food Law and Regulation
- FPE 520 Low-Acid Canned Food Regulations and Microbiology
- FPE 523 Food Engineering Process Delivery
- FPE 526 Engineering Principles of Food
- FPE 531 HACCP Planning and Implementation
- FPE 593 Seminar Series
- FPE 594 Special Projects
- FPE 597 Special Problems

Students can enroll in FPE 594 and 597 with a maximum of 6 credit hours total between both courses with IFSH advisor approval. However, when 597 is used as a short course, the total credit hours must not exceed 8 between 594 and 597.

Students must take at least two of the following:

FPE Electives (5-6 credit hours)

- CHE 426 Statistical Tools for Engineers
- CHE 439 Numerical Analysis
- CHE 494 Chemical Process Design
- CHE 560 Statistical Quality and Process Control
- CHE 577 Bioprocess Engineering
- ENVE 513 Biotechnological Processes in Wastewater Treatment
- ENVE 542 Environmental Unit Processes

Students may enroll in a ChBE course elective that is not listed above, with IFSH advisor approval.

Master of Science in Chemical Engineering

32 credit hours Thesis

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

Core Courses

CHE 525 Chemical Reaction Engineering CHE 535 Applications of Mathematics to Engineering CHE 551 Advanced Transport Phenomena

CHE 553 Advanced Thermodynamics

A minimum grade point average of 3.0/4.0 is required for core courses. Aside from the core courses, coursework may be selected (with advisor 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 of this bulletin.

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

Master of Science in Food Process Engineering

32 credit hours

Thesis and Oral Defense (written thesis report required)

Program Description

The Food Process Engineering (FPE) programs at IFSH are directed toward students with background and career objectives in engineering related disciplines. GPA and test scores are just two of the several important factors considered. Admission to graduate study in food process engineering generally requires a bachelor's degree in chemical, agricultural, food, or environmental engineering; food science; chemistry; biology; or a related field. Depending on the student's background, additional proficiency courses, some of which may not count toward the degree, may be required. See the department's list of applicable undergraduate courses. Students in the Food Process Engineering programs should consult with their IFSH, IIT faculty advisor to plan a program of study best suited to their background and interests. Students enrolled in FPE Master of Science programs must register for six to eight credit hours of research. Research work will usually be conducted at the Moffett Campus; research topics will be selected from the food safety, food process engineering, food biotechnology, or related topics.

Candidates are required to take a total of 32 credit hours, 18 of which are the required courses listed below, 6-8 credit hours in Research and Thesis, 5-6 credit hours must be taken from Chemical and Biological Engineering Department courses, and the remaining 1-3 credit hours can be taken from FPE electives, if needed.

Proficiency Requirement

These courses may be required if the student has not taken an equivalent course at the undergraduate level:

- CHE 406 Transport Phenomena (3)
- CHE 423 Chemical Reaction Engineering (3)
- CHE 435 Process Control (3)

Core Course Requirements (18 credit hours)

- FPE 505 Food Microbiology
- FPE 506 Food Microbiology Laboratory
- FPE 521 Food Process Engineering
- FPE 522 Advanced Food Process Engineering
- FPE 524 Fundamentals of Food Science and Technology
- FPE 541 Principles of Food Packaging

Core Research Thesis Requirements (6-8 credit hours) FST 591 Research and Thesis

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 IIT faculty members from various departments, IFSH/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.

The student must have a minimum grade point average of 3.0/4.0 in the core areas. In addition to the core courses, coursework may be selected (with adviser approval) to satisfy the needs of the individual student or may be concentrated in one of the following areas of specialization:

- · Food Processing Operations
- · Food Packaging
- · Food Safety
- · Food Biotechnology
- · Process and Quality Monitoring and Control

Elective Requirements (5-6 credit hours)

Students must take two courses from the following group of chemical and environmental engineering courses: (5-6 credit hours)

- CHE 426 Statistical Tools for Engineers
- CHE 439 Numerical Analysis
- CHE 494 Chemical Process Design
- CHE 560 Statistical Quality and Process Control
- CHE 577 Bioprocess Engineering
- ENVE 513 Biotechnological Processes in Wastewater Treatment
- ENVE 542 Environmental Unit Processes

FPE Electives

(1-3 credit hours)

- FPE 501 Nutrition, Metabolism and Health
- FST 502 Research Project: Design, Delivery and Dissemination
- FPE 504 Food Biotechnology
- FPE 507 Food Analysis
- FPE 511 Food Law and Regulation
- FPE 520 Canned Food Regulations and Microbiology
- FPE 523 Food Engineering Process Delivery
- FPE 526 Engineering Principles of Food
- FPE 531 HACCP Planning and Implementation
- FPE 593 Seminar Series
- FPE 594 Special Projects
- FPE 597 Special Problems

Student may enroll in a ChBE course that is not listed above, with IFSH advisor approval.

Doctor of Philosophy

84 credit hours Qualifying exam Comprehensive exam Thesis proposal Dissertation and oral defense

The doctorate 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. Coursework must include 15 credits of core courses.

Core Courses

- CHE 551 Advanced Transport Phenomena
- CHE 553 Advanced Thermodynamics
- CHE 525 Chemical Reaction Engineering
- CHE 535 Applications of Mathematics to Engineering
- CHE 530 Advanced Process Control or CHE 536 Computational Techniques in Engineering

A minimum grade point average of 3.0/4.0 is required in the core courses. Please refer to the credit requirements section at the front of this bulletin for additional details.

Students should consult the Transfer Credits section at the front 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 4 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 advisor 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.

Certificate Programs

The department offers 8 graduate certificate programs, with one available only via the Internet. These programs provide students with post-baccalaureate knowledge of an area of specialization within chemical. Students in these programs register as certificate students.

Biological Engineering

This program provides an introduction to the field of biological engineering and its application in biological, biomedical, and environmental processes. Students must complete four courses (12 credits) to receive the certificate.

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. Students must complete 3 of the following 5 courses (9 credits) to receive the certificate. With the consent of the advisor, students may substitute one or two required courses by appropriate courses listed under Energy/Environment/Economics (E^3), found in this bulletin.

Food Process Engineering

This program provides an introduction to the field of food engineering, with applications of chemical engineering to food manufacturing and food safety. Courses are offered at IFSH via the internet, with the exception of lab courses.

Required Courses

FPE 521 Food Process Engineering FPE 522 Advanced Food Process Engineering

Food Processing Specialist

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 credits) to receive the certificate. 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.

Required Course

CHE 577 Bioprocess Engineering

AND at least three courses from the biology requirements and the elective courses listed under the Master of Biological Engineering

Required Courses

At least three from the following:

- CHE 541 Renewable Energy Technologies
- CHE 542 Fluidization & Gas-Solids Flow Systems
- CHE 543 Energy, Environment and Economics
- CHE 565 Fundamentals of Electrochemistry
- CHE 567 Fuel Cell Fundamentals

AND two of the following:

- CHE 406 Transport Phenomena
- CHE 560 Statistical Quality and Process Control
- CHE 577 Bioprocess Engineering
- FPE 501 Nutrition, Metabolism and Health
- FPE 502 Research Projects: Design, Delivery and Dissemination
- FPE 504 Food Biotechnology
- FPE 505 Food Microbiology
- FPE 506 Food Microbiology Laboratory
- FPE 507 Food Analysis
- FPE 511 Food Law and Regulation
- FPE 524 Fundamentals of Food Science and Technology
- FPE 531 HACCP Planning and Implementation
- FPE 541 Principles of Food Packaging

FPE 520 Low-Acid Canned Food Regulations and Microbiology

Required Courses

- FPE 522 Advanced Food Process Engineering
- FPE 523 Food Engineering Process Delivery
- FPE 526 Engineering Principles of Food
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. Students must complete three courses (nine credits) to receive a certificate.

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. Students must complete four courses (12 credits) to receive a certificate.

Polymer Science and Engineering

This program introduces fundamentals of polymerization and polymer synthesis, polymer kinetics, polymer processing and characterizations. Students must take four courses (12 credits) to receive the certificate.

Required Courses

At least one of the following courses:

CHE 542 Fluidization and Fluid/Particle Flow Systems CHE 489 Fluidization

AND one/two of the following:

CHE 582 Interfacial Colloidal Phenomena CHE 586 Particle Technology

Required Courses

CHE 583 Pharmaceutical Engineering CHE 585 Drug Delivery Systems

CHE 511 Regulatory Issues in Pharmaceutical Processes

AND one of the following:

CHE 514 Process Analytical Technology CHE 560 Statistical Quality and Process Control

Required Courses

CHE 470 Introduction to Polymer Science and Engineering (Prerequisite for all other courses in this certificate program.)

AND three of the following:

CHE 538 Polymerization Reaction Engineering

CHE 555 Polymer Processing (Prerequisite: CHE 406)

CHEM 535 Advanced Polymer Chemistry

CHEM 542 Characterization of Polymers (Same as MMAE 579)

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. Students must take four courses (12 credits) to receive the certificate.

Required courses

At least one course from each of the following groups:

CHE 426 Statistical Tools for Engineers

CHE 533 Statistical Analysis of Systems

CHE 560 Statistical Quality and Process Control

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CHE 435 Process Control

CHE 530 Advanced Process Control (Prerequisite: CHE 435, or equivalent)

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CHE 508 Process Design Optimization

Course Descriptions

Numbers in parentheses respectively indicate class, lab and credit hours. Note: Core courses are available once per year. Other courses may be offered less frequently.

Chemical Engineering

CHE 503

Thermodynamics

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

CHE 506

Entrepreneurship & 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. (2-0-2)

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.

(3-0-3)

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)] (3-0-3)

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)]

(3-0-3)

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. (3-0-3)

(3-0-3)

CHE 545

Metabolic Engineering

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)] (3-0-3)

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. Core course.

(3-0-3)

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)] (3-0-3)

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. Requires senior standing. (3-0-3)

CHE 542

Fluidization & Gas-Solids Flow Systems

Fluidization phenomena (bubbling, slugging, elutriation, and jets in fluidized beds). Multiphase flow approach to fluidization and gas/solids flow systems. Kinetic theory approach to fluid/particle flow systems. Analysis of flow of particles in pneumatic conveying lines (dilute flow) and stand pipe (dense flow). Hydrodynamic analysis of spouted and circulating fluidized beds. Examples from current literature on applications of multiphase flow.

Prerequisite(s): [(CHE 551 and CHE 535)] (3-0-3)

CHE 543

Energy, Environment & Economics

The linkage of energy, environmental and economic issues. The impact of energy supply and end use on human wellbeing 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. (3-0-3)

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.

CHE 553

Advanced Thermodynamics

Advanced thermodynamics for research-oriented graduate students. The course covers the fundamental postulates of thermodynamics and introductory statistical mechanics, with applications to pure fluids, fluid mixtures, elastic solids, surfaces and macromolecules.

Prerequisite(s): [(CHE 351 and CHE 451)] (3-0-3)

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)] (3-0-3)

CHE 560

Statistical Quality & 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. (3-0-3)

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.

(3-0-3)

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. (3-0-3)

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. (2-1-3)

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)] (3-0-3)

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 cultures and their applications. (3-0-3)

CHE 580

Biomaterials

Metal, ceramic, and polymeric implant materials. Structureproperty relationships for biomaterials. Interactions of biomaterials with tissue. Selection and design of materials for medical implants. (3-0-3)

CHE 582

Interfacial & Colloidal Phenomena with Applications

Applications of the basic principles of physical chemistry, surfactants and interfacial phenomena, surface and interfacial tension, adsorption of surfactants from solutions, spreading, contact angles, wetting, electro-kinetic phenomena, rheology, dynamic interfacial properties, mass transport across interfaces. Applications include emulsions, foams, dispersions, tribology, detergency, flotation, enhanced oil recovery, suspension, emulsion polymerization and liquid membranes.

Prerequisite(s): [(CHE 351) OR (CHE 451)] AND [(CHE 406)] (3-0-3)

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. (3-0-3)

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. (3-0-3)

CHE 585

Drug Delivery

Principle of diffusion in liquids, membranes, 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. (3-0-3)

CHE 591

Research & Thesis for M.S. Degree

Research and thesis writing.

(Credit: Variable)

CHE 593

Seminar in Chemical Engineering Presentations on recent developments in the field by academic and industrial visitors. (1-0-1)

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 Continuance of residence. (0-0-1)

CHE 691 Research & Thesis for Ph.D. Degree Research and thesis writing.

(Credit: Variable)

Food Process Engineering

FPE 501

Nutrition, Metabolism, & Health

Study of structures, types, and metabolism of carbohydrates, lipids, and proteins. Discussion of the biological roles of vitamins and minerals. Application and integration of metabolic knowledge with health promotion and chronic disease. (3-0-3)

FPE 502

Research Project: Design, Delivery, & Dissemination

This course is an introduction to designing, conducting, and reporting on scientific research. Topics will include defining a problem and creating a research proposal, experimental design, data collection and analysis, and a written and oral presentation of results. Same as FST 502. (3-0-3)

FPE 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 prediction, genomic map construction, and structural and functional prediction of proteins. Applications of DNA fingerprinting techniques in food safety and public health. Prerequisite: Biology or Microbiology.

(3-0-3)

FPE 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. Core course. Prerequisite: Introductory Microbiology or Food Science. (3-0-3)

FPE 506

Food Microbiology Laboratory

Basic microbiological techniques and safe laboratory practices. Introductory Food Microbiology. Isolation of pathogenic bacteria. Spoilage microorganisms. Fermentation. Environmental monitoring. Rapid identification tests. Sporeformers. Prerequisite: Microbiology or Food Science. (0-3-3)

FPE 507

Food Analysis

Techniques for analyzing food toxins, food constituents of public health concern, intentional and unintentional food additives, modern separation and analytical techniques. (3-0-3)

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FPE 511 Food Law & Regulation

Legal and scientific issues in regulating the nation's food supply and nutritional status. Role of regulatory agencies; Federal Food, Drug, and Cosmetic Act; definitions and standards for food and adulterated foods. Manufacturing processed foods in compliance with regulations. (3-0-3)

FPE 520

Low-Acid Canned Food Regulations & Microbiology

Regulatory requirements for the U. S. Food and Drug Administration and the broad microbial issues associated with low-acid canned foods (LACF) products. Topics will include the U. S. Food Drug & Cosmetic (FD&C) Act, Emergency Permit Control, 21 Code of Federal Register (CFR) parts 108, 113, and 114, record requirements, sources of microbial contamination, characteristics of clostridium botulinum, mesosphelic sporeformers, indicator organisms, and introduction to microbial heat resistance. Students must have background in microbiology, food science, and biochemistry. Instructor permission is required. (3-0-3)

FPE 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. (3-0-3)

FPE 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. Instructor permission is required.

Prerequisite(s): [(FPE 520) OR (FPE 521) OR (FST 521)] (3-0-3)

FPE 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. Instructor permission is required.

Prerequisite(s): [(FPE 522)] (3-0-3)

FPE 524

Fundamentals in Food Science & Technology

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. (3-0-3)

FPE 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. Instructor permission is required.

Prerequisite(s): [(FPE 523)]

(3-0-3)

FPE 531

HACCP Planning & 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. (3-0-3)

FPE 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. (3-0-3)

FPE 591

Research & Thesis M.S.

Research and thesis for master of science students. (Credit: Variable)

FPE 593

Seminar on Food Safety & Technology

Students attend seminars offered during the semester. Each student is also required to give a 30 minute presentation on a topic of his/her interest or a research project on which she/he has worked. (Credit: 1 Hour)

(1-0-1)

FPE 594

Special Projects

Advanced projects involving analysis of food safety processing, packaging and biotechnology systems. (Credit: 1-6 hours) (Credit: Variable)

FPE 597

Special Problems

Special projects focusing on current problems, issues of professional relevance. Topics selected from chemical engineering, food process engineering, food safety, packaging, biotechnology. Provides opportunities for in-depth analysis of current trends and issues. Repeatable to a maximum of six credit hours. (Credit: variable) (Credit: Variable)

FPE 600

Continuing of Residence

Continuing of residence. (1-0-1)

FPE 772

Design/Devlpng Food Products

Methodologies for designing and developing food products, assessment of alternatives for low-fat, low-calorie food product alternatives, substitute ingredients, market evaluation, process modification. Development of prototypes, process optimization and evaluating consumer acceptance. Impact of microbiology, sanitation and nutrition on product development. (3-0-3)

Undergraduate Courses Available to Graduate Students

With the approval of their advisors, students in the chemical and biological engineering graduate programs may apply up to 12 credits hours to their program from 400level undergraduate courses. This does not apply to students pursuing the dual masters degree in chemical engineering and computer science.

Department of Civil, Architectural, and Environmental Engineering

228 Alumni Hall 3201 S. Dearborn St. Chicago, IL 60616 312.567.3540 312.567.3519 fax cae@iit.edu www.iit.edu/engineering/cae/

Chair:

Gongkang Fu

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

Degrees Offered

Master of Architectural Engineering Master of Construction Engineering and Management Master of Environmental Engineering Master of Geoenvironmental Engineering Master of Geotechnical Engineering Master of Public Works Master of Structural Engineering Master of Transportation Engineering Master of Science in Civil Engineering with specialization in:

Architectural Engineering Construction Engineering and Management Geotechnical Engineering Geoenvironmental Engineering Structural Engineering Transportation Engineering

Master of Science in Environmental Engineering Doctor of Philosophy in Civil Engineering Doctor of Philosophy in Environmental Engineering

Joint-Degree Program

Bachelor of Architecture/Master of Civil Engineering

Certificate Programs

Air Resources Construction Management Earthquake and Wind Engineering Design Geoenvironmental Engineering Hazardous Waste Management Indoor Air Quality Infrastructure Engineering and Management Transportation Systems Planning Waste and Wastewater Treatment

Research Facilities

Research facilities include laboratories devoted to concrete structures, structural models, metal structures, materials, architectural engineering, geotechnical engineering, transportation engineering, construction engineering and management, and environmental engineering. In addition, faculty and graduate students have access to regional facilities such as the Argonne National Laboratory. 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 and geoenvironmental engineering, public works, structural engineering, and transportation engineering.

In architectural engineering, faculty conduct research in acoustics, airflow and thermal modeling, enery conservation, indoor air quality, 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 enginering research areas include air pollution, energy and sustainability, hazardous waste engineering, indoor air quality, and wastewater engineering.

Geotechnical and geonenvironmental 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, inelsatic behavior and non-linear analysis of steel structures, and bridge engineering.

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

Faculty

Anderson, Paul, Associate Professor of Environmental Engineering. B.S., Purdue University; M.S., University of California-San Diego; Ph.D., University of Washington. Physical-chemical processes in water and wastewater treatment, water resources management, industrial ecology.

Arditi, David, Professor of Civil and Architectural Engineering. B.S., M.S., Middle East Technical University (Turkey); Ph.D., Loughborough University of Technology (United Kingdom). Construction engineering and management.

Budiman, Jeffry S., Associate Professor of Civil and Architectural Engineering. B.S., Bandung Institute of Technology (Indonesia); M.S., Illinois Institute of Technology; Ph.D., University of Colorado-Boulder. Geotechnical and geoenvironmental engineering.

Du, Lili, Assistant Professor of Civil and Architectural Engineering. B.S., Xi'an Jiaotong University (China); M.S., Tsinghua University (China); M.S., Ph.D., Rensselaer Polytechnic Institute. Dynamic traffic assignment, intelligent transportation systems, and network economics.

Fu, Gongkang, Professor of Civil and Architectural Engineering and Chair of the Department. B.S., M.S., Tongji University (China); Ph.D., Case Western Reserve University. Bridge engineering, probabilistic mechanics, infrastructure system engineering.

Guralnick, Sidney A., Perlstein Distinguished Professor of Engineering, Emeritus, and Director of the Advanced Building Materials and Systems Center. B.S., Drexel Institute of Technology; M.S., Ph.D., Cornell University. Structural engineering and materials of construction.

Khisty, C. Jotin, Professor Emeritus of Civil and Architectural Engineering. B.S., Nagpur University (India), M.S., M.C.P., University of Cincinnati; Ph.D., The Ohio State University. Transportation systems, traffic engineering and infrastructure systems.

Li, Zongzhi, Associate Professor of Civil and Architectural Engineering. B.S., Shanghai Jiaotang University; B.E. Changan University, (China); MSCE, MSIE, Ph.D., Purdue University. Multimodal transportation systems analysis, evaluation, and asset management, and network economics.

Menches, Cindy, Assistant Professor of Civil and Architectural Enginering. B.S., University of Southern California; M.S., The Pennsylvania State University; Ph.D., University of Wisconsin-Madison. Construction engineering and management. Modares, Mehdi, Assistant Professor. B.S, Tehran Azad Unversity (Iran); MS., Cleveland State University; Ph.D., Case Western Reserve University. Computational mechanics, solid mechanics.

Mohammadi, Jamshid, Professor of Civil and Architectural Engineering and Associate Dean for Academic Affairs in the Graduate College. B.S., M.S., University of Teheran (Iran); M.S., Ph.D., University of Illinois, Urbana-Champaign. Structural reliability and bridge engineering.

Moschandreas, Demetrios J., Professor of Environmental Engineering. B.S., Stetson University; M.S., University of Kentucky; M.S., Ph.D., University of Cincinnati. Air quality transport, exposure analysis, risk assessment, indoor air quality, Environmental Index theory and application, sustainable environmental development.

Noll, Kenneth E., Professor of Environmental Engineering. B.S., Michigan Technological University; M.S., Ph.D., University of Washington. Design of air pollution control devices, study of atmospheric aerosols, VOC emissions from wastewater treatment plants, and physical and chemical changes and fates of toxic air.

Novak, James, Senior Lecturer of Engineering Graphics. B.S., M.S., Illinois Institute of Technology. Engineering graphics.

Pagilla, Krishna, Professor of Environmental Engineering. B.E., Osmania University (India); M.S., University of Oklahoma; Ph.D., University of California-Berkeley. Water and wastewater engineering, environmental microbiology, biological nutrient control, soil remediation, and sludge treatment.

Shen, Jiehua J., Associate Professor of Civil and Architectural Engineering. B.S., Hefei University (China); M.S., Chinese Academy of Sciences; Ph.D., University of California-Berkeley. Structural engineering and seismic design.

Snyder, Mark E., Senior Lecturer of Civil and Architectural Engineering. B.S., M.S., Creighton; M.S., Illinois Institute of Technology; Ph.D., Texas Tech University. Building energy and lighting systems, measurement techniques, fire engineering.

Stephens, Brent, Assistant Professor of Civil and Architectural Engineering. B.S., Tennessee Technological University; M.S., Ph.D., University of Texas-Austin. Architectural engineering, building energy efficiency, indoor air quality, HVAC filtration, energy and air quality measurements.

Admission Requirements

Cumulative undergraduate GPA minimum: 3.0/4.0 GRE minimum score: M.S./MAS: 900 (quantitative + verbal), 2.5 (analytical writing) Ph.D.:1000 (quantitative + verbal), 3.0 (analytical writing) TOEFL minimum: 550/213/80*

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

* Paper-based test score/computer-based test score/interet-based test score.

Master of Architectural Engineering Master of Construction Engineering and Management Master of Environmental Engineering Master of Geoenvironmental Engineering Master of Geotechnical Engineering Master of Public Works Master of Structural Engineering Master of Transportation Engineering

32 credit hours (minimum)

These master's 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 M.S. program. Candidates in these programs must

Master of Architectural Engineering

This program is oriented toward students who need to develop more knowledge about buildings. Students are expected to have educational backgrounds in disciplines such as architecture, structural engineering, mechanical engineering, and/or electrical engineering. The program covers the three basic aspects of architectural engineering: building systems, structures, and construction management.

This program involves four core courses, four or five elective courses from one field of concentration, and two

Master of Construction Engineering and Management

The professional master's program 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.

Master of Environmental Engineering

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 advisor, 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. complete a minimum of 32 credit hours, up to three of which may be a special project course, CAE 597 or ENVE 597. Up to 12 credit hours of 400-level undergraduate coursework (except CAE 431 and CAE 432) may be included in the Professional Master's program with prior advisor approval. No thesis or comprehensive examination is required for completion of the degree.

courses from any relevant field of concentration, general background courses, or graduate courses offered by the College of Architecture.

Core Courses

- CAE 471 Construction Planning and Scheduling
- CAE 513 Building Science CAE 542 Acoustics and Lighting
- CAE 542 Acoustics and Lighting
- CAE 574 Economic Decision Analysis in Civil Engineering

Core Courses

- CAE 570 Legal Issues in Civil Engineering
- CAE 571 Lean Construction and Control
- CAE 574 Economic Decision Analysis in Civil Engineering
- CAE 577 Construction Equipment Management

Core Courses

- ENVE 426 Statistical Tools for Engineers
- ENVE 501 Environmental Chemistry
- ENVE 506 Chemodynamics
- ENVE 542 Physiochemical Processes in Environmental Engineering
- ENVE 580 Hazardous Wastes Engineering

Master of Geoenvironmental Engineering and Master of Geotechnical Engineering

The geoenvironmental and geotechnical engineering programs provide 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.

Geotechnical Engineering Core Courses

- CAE 562 Engineering Behavior of Soils
- CAE 564 Design of Foundations, Embankments and Earth Structures
- CAE 565 Rock Mechanics and Tunneling
- CAE 566 Earthquake Engineering and Soil Dynamics

Geoenvironmental Engineering Core Courses

- CAE 562 Engineering Behavior of Soils
- CAE 567 Physicochemical Behavior of Soils
- CAE 589 Groundwater Hydrology and Sampling
- CAE 590 Geotechnical Landfill Design and Maintenance

Master of Public Works (Infrastructure Engineering and Management)

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

Master of Structural Engineering

IIT's professional program 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.

Master of Transportation Engineering

With a Master of 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.

Core Courses

- CAE 574 Economic Decision Analysis in Civil Engineering
- CAE 575 Systems Analysis in Civil Engineering
- PA 501 Introduction to Public Administration
- PA 551 Public Infrastructure Management

Core courses

MMAE 501 Engineering Analysis 1

 \mathbf{OR}

- CAE 514 Mathematical Methods for Structural Engineering
- CAE 503 Advanced Structural Theory
- CAE 518 Advanced Reinforced Concrete
- CAE 525 Advanced Steel Structures

Core Courses (choose four, with advisor consent)

- CAE 523 Statistical Analysis of Engineering Data
- CAE 543 Demand Models for Urban Transportation
- CAE 544 Urban Transportation Planning
- CAE 546 Public Transportation Systems
- CAE 548 Transportation Systems Management
- CAE 555 Transportation Systems Evaluation
- CAE 575 Systems Analysis in Civil Engineering
- ENVE 527 Statistical Analysis of Systems

Master of Science in Civil Engineering

32 credit hours Thesis and oral defense

Six technical areas (architectural, construction, geoenvironmental, geotechnical, structural, and transportation engineering) are included in the M.S. program. Degree candidates in the Master of Science program must complete a minimum of 32 credit hours, six to eight of which

Master of Science in Environmental Engineering

32 credit hours Thesis

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. Candidates are required to take at least 32 credit hours, 15 credits of which must be from the environmental engineering core courses listed below.

Core courses

 ENVE 426 Statistical Tools for Engineers
 ENVE 501 Environmental Chemistry
 ENVE 506 Chemodynamics
 ENVE 542 Physicochemical Processes in Environmental Engineering
 ENVE 580 Hazardous Waste Engineering are for research and thesis. Up to 12 credit hours of 400-level undergraduate coursework [except CAE 431 (Steel Design) and CAE 432 (Concrete and Foundation Design)] may be included in the M.S. program with prior advisor approval. An oral defense of the thesis constitutes the comprehensive examination, and no additional written comprehensive examination is required.

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

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. In addition, master's degree students typically 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.

Bachelor of Architecture/Master of Science in Civil Engineering Bachelor of Architecture/Master of Construction Engineering and Management Bachelor of Architecture/Master of Structural Engineering

Qualified students regularly enrolled at IIT may earn both the Bachelor of Architecture and the professional master's degree. They must complete preparatory courses for the professional master's program prior to entry into the combined program.

Students who anticipate entry into the combined B.Arch. and M.S. in Civil Engineering program and who intend to specialize in structural engineering must successfully complete the following courses as part of their undergraduate program in architecture: MATH 151, MATH 152, MATH 251, MATH 252, PHYS 123, PHYS 221, PHYS 224, MMAE 200/CAE 200, MMAE 202/CAE 202, CAE 303, CAE 304, CAE 307, CAE 310, CAE 431 and CAE 432 (in place of MATH 119, MATH 122, and all structural engineering courses for the Architecture major). Students who anticipate entry into the Master of Construction Engineering and Management are not required to complete any additional courses as part of the technical electives in their undergraduate program in architecture.

Students who anticipate entry into the Master of Structural Engineering program must successfully complete the following courses as part of their undergraduate program in Architecture: MATH 151, MATH 152, MATH 251, MATH 252, PHYS 123, PHYS 221, PHYS 224, MMAE 200/CAE 200, MMAE 202/CAE 202, CAE 303, CAE 304, CAE 307, CAE 310, CAE 431 and CAE 432 (in place of MATH 119, MATH 122, and all structural engineering courses for the Architecture major).

For undergraduate course descriptions, students should refer to the undergraduate bulletin.

Doctor of Philosophy in Civil Engineering

84 credit hours, including master's degree (A maximum of 42 credit hours may be transferred from another institution. Students should consult the rules for transfer credit within this bulletin) Qualifying exam Comprehensive exam Dissertation (24 credit hours) Oral defense

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 IIT. To be admitted to candidacy, students must successfully complete a qualifying examination. The department may waive this requirement for students who hold an M.S. degree from IIT in the same field. This examination should be completed within three semesters of entry into the program. The student selects a research advisor after he or she is admitted to candidacy. The research project must be in harmony with the interests of

Doctor of Philosophy in Environmental Engineering

84 credit hours Qualifying exam Comprehensive exam Thesis proposal Dissertation and oral defense

The doctorate degree in environmental engineering is awarded in recognition of mastery in environmental engineering and upon demonstration of an ability to make substantial creative contributions to knowledge in environmental engineering. The recipients of these derees will be capable of a continuing effort toward advancement of knowledge and achievement in research while pursuing an academic or industrial research career. Typically, the program of study includes 30-40 percent environmental engineering coursework, 40-50 percent research, and 10-30 percent in other fields of study. The coursework must include 15 credits of core environmental engineering courses listed in the section describing the Master of Science in Environmental Engineering.

Students should consult the Transfer Credits section 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 core areas, including environmental chemistry, chemodynamics, environmental systems and analysis, and physiochemical processes. the faculty and with the facilities of the department. Offcampus research for the dissertation is possible. In those cases, the student must register for CAE 691 during each semester in which the thesis is being prepared.

The candidate should complete 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 reearch committee approved by the chairperson. The candidate presents the research proposal and answers questions of a general professional nature.

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.

The comprehensive examination is oral and may include a written exam based on the student's performance on the qualifying exam. Exam questions will be formulated by the members of the Ph.D. examining committee. The examination will also include an oral presentation and discussion of one or more research articles 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 advisor and approved and appointed by the chairperson at least three weeks prior to the examination.

The thesis proposal approval examination should be conducted after the comprehensive exam and at least one year before the final thesis defense. This oral exam is administered by the Ph.D. thesis committee.

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

Certificate Programs in Civil Engineering

Construction Management

Required Courses (choose four)

CAE 470	Construction Methods and Cost Estimating
CAE 471	Construction Planning and Scheduling
CAE 472	Construction Site Operation
CAE 473	Construction Project Administration
CAE 570	Legal Issues in Civil Engineering
CAE 571	Advanced Construction Scheduling and
	Control
CAE 572	Construction Cost Accounting and Control

Earthquake and Wind Engineering Design

Required Courses (choose four)

CAE 410	Introduction to Wind and Earthquake
	Engineering
CAE 420	Introduction to Dynamics of Structures

- CAE 518 Advanced Reinforced Concrete
- CAE 525 Advanced Steel and Composite Structures

Geoenvironmental Engineering

Required Courses

CAE 567	Physicochemical Behavior of Soils
CAE 589	Ground Water Hydrology and Sampling
CAE 590	Geotechnical Landfill Design and
	Maintenance

Infrastructure Engineering and Management

Required Courses

PA 501Introduction to Public AdministrationPA 551Public Works Management

Elective Courses (choose two)

- CAE 408 Bridge and Structural Design
- CAE 416 Facility Design of Transportation Systems
- CAE 417 Railroad Engineering and Design
- CAE 419 Transportation Engineering and Design
- CAE 471 Construction Planning and Scheduling
- CAE 486 Soil and Site Improvement
- CAE 508 Bridge Inspection, Rehabilitation, Repair and Management
- CAE 523 Statistical Analysis of Engineering Data
- CAE 539 Introduction to Geographic Information Systems

- CAE 573 Construction Management with BIM $\,$
- CAE 574 Economic Decision Analysis in Civil Engineering
- CAE 575 Systems Analysis in Civil Engineering
- CAE 577 Construction Equipment Management
- CAE 578 Construction Claims Management
- CAE 579 Real Estate Fundamentals for Engineers and Architects
- CAE 585 Legal Aspects of Real Estate and Development
- CAE 582 Structural Wind and Earthquake Engineering
- CAE 583 Seismic Retrofit and Earthquake Hazard Reduction
- CAE 586 Seismic Building Design of Building and Bridge Structures

AND one of the following:

ENVE 580 Hazardous Waste Engineering

- ENVE 585 Groundwater Contamination and Pollutant Transport
- CAE 541 Pavement Evaluation and Management
- CAE 544 Urban Transportation Planning
- CAE 546 Public Transportation Systems
- CAE 548 Transportation Systems Management
- CAE 549 Transportaion Economics, Development, and Policy
- CAE 555 Transportation Systems Evaluation
- CAE 568 Transportation Asset Management
- CAE 574 Economic Decision Analysis in Civil Engineering
- CAE 575 Systems Analysis in Civil Engineering
- CAE 581 Algorithms in Transportation
- CAE 590 Geotechnical Landfill Design and Maintenance
- ENVE 404 Water and Wastewater Engineering
- ENVE 551 Design of Sanitary Engineering Process
- ENVE 527 Statistical Analysis of Systems

Transportation Systems Planning

Required Courses (choose two)

- CAE 523 Statistical Analysis of Engineering Data
- CAE 544 Urban Transportation Planning
- CAE 546 Public Transportation Systems CAE 548 Transportation Systems Management
- CAE 555 Transportation Systems Evaluation
- CAE 575 Systems Analysis in Civil Engineering

Elective Courses (choose two)

CAE 406	Facility Design of Transportation Systems
${\rm CAE}~417$	Railroad Engineering and Design
${\rm CAE}~419$	Urban Transportation Planning
CAE 539	Introduction to Geographic Information
	Systems
CAE F40	Transmission Francisco Decelemente

- CAE 549 Transportaion Economics, Development, and Policy
- CAE 568 Transportation Asset Management
- CAE 574 Economic Decision Analysis in Civil Engineering
- CAE 581 Algorithms in Transportation
- ENVE 527 Statistical Analysis of Systems

Certificate Program in Architectural Engineering

Architectural Engineering

Required Course

CAE 531 Physical Performance of Buildings

Elective Courses (choose two)

- CAE 461 Plumbing and Fire Protection Design
- CAE 464 $\,$ HVAC Design
- CAE 507 Control of Sound and Vibrations in Buildings
- CAE 509 Analysis and Design of Acoustic Spaces
- CAE 521 Building Illumination Design
- CAE 524 Design of Building Enclosures
- CAE 526 Energy Conservation Design in Buildings
- CAE 528 Communication and Electrical Systems in Buildings
- CAE 542 Acoustics and Lighting
- CAE 597 Special Topics in Architectural Engineering

Certificate Programs in Environmental Engineering

Air Resources

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

Required Course

ENVE 570 Air Pollution Meteorology

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.

Required Course

ENVE 580 Hazardous Waste Engineering

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.

Required Course

ENVE 576 Indoor Air Pollution

Waste 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.

Elective Courses (choose two)

ENVE 572 Ambient Air Monitoring
ENVE 575 Control of Toxic Air Pollution
ENVE 577 Design of Air Pollution Control Devices
ENVE 578 Physical and Chemical Processes for Industrial Gas Cleaning

Elective Courses (choose two)

 ENVE 506 Chemodynamics
 ENVE 542 Physicochemical Processes in Environmental Engineering
 ENVE 577 Design of Air Pollution Control Devices
 ENVE 585 Groundwater Contamination

Elective Courses (choose one)

ENVE 426 Statistical Tools for EngineersENVE 527 Statistical Analysis of SystemsENVE 575 Control of Toxic Air PollutionMMAE 452 Air Conditioning and RefrigerationBIOL 514 Toxicology

Required Courses

- ENVE 513 Biotechnological Processes in Environmental Engineering
- ENVE 542 Physicochemical Processes in Environmental Engineering
- ENVE 551 Industrial Waste Treatment
- $\operatorname{ENVE}555\,$ Industrial Waste Treatment Design Criteria
- ENVE 561 Design of Sanitary Engineering Processes

Course Descriptions

Civil and Architectural Engineering

CAE 502

Acoustics & 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. (3-0-3)

CAE 503

Advanced Structural Theory

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 310) OR (MMAE 501*)] An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

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 and others.

(3-0-3)

CAE 507

Control of Sound & Vibration in Buildings

Basic sound physics and sound propagation in enclosed spaces. Sound and vibration sources in and out of buildings. Theories of sound transmission through building elements. Effects of noise and vibration on man and buildings, criteria and standards. Design of noise control systems. Calculation of airborne and impact sound insulation. Noise and vibration control implementations in various indoor spaces, such as residential units, offices, schools and mechanical rooms. Prerequisite(s): [(CAE 502)]

(3-0-3)

CAE 508

Bridge Inspction, Rehabilitation, Repair & Management

Elements of bridge management, rating and inspection process. Life-cycle, project-level and network-level analyses, condition assessment, case studies, and repair, retrofit and replacement alternatives and their relation to infrastructure management.. (3-0-3)

CAE 509

Analysis & Design of Acoustic Spaces

This course will discuss the design of acoustic spaces such as conference rooms, classrooms, lecture halls, music halls, theater, churches, recording studio, and home theater. Course covers the selection and determination of appropriate steady state, spatial, and temporal acoustic measures such as background noise levels, reverberation time, speech transmission index, and interaural cross correlation, as well as the selection of building materials and layout of rooms to meet those requirements.

 $\begin{array}{l} \mbox{Prerequisite(s): [(CAE \ 502) \ OR \ (CAE \ 542)]} \\ (3-0-3) \end{array}$

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. (3-0-3)

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. (3-0-3)

CAE 512

Computer Modeling of Fire

Introduction to fire heat transfer processes and fire testing materials; application of a set of quantitative engineering tools (fire models) to construct a description of conditions that occur or might occur during the course of a fire; life and structural impacts from hostile fires in buildings. (3-0-3)

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. (3-0-3)

CAE 518

Advanced Reinforced Concrete

Mechanical properties of hardened concrete, including creep phenomena. Ultimate strength of columns, beams and beam-columns. Introduction to limit analysis of frames and yield-line analysis of plates.

Prerequisite(s): $[(CAE 432^*)]$ An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

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 310 and CAE 431)] (4-0-4)

Building Illumination Design

An intensive study of the calculation techniques and qualitative aspects of good luminous design. Topics covered include photometric quantities and color theory, visual perception, standards, daylight and artificial illumination systems, radiative transfer, fixture and lamp characteristics, control devices and energy conservation techniques. Design problems, field measurements, computer and other models will be used to explore the major topics. Requires senior standing.

Prerequisite(s): [(CAE 502) OR (CAE 542)] (3-0-3)

CAE 522

Structural Model Analysis

Theory of measurements, statistics, similitude, and model laws and the usefulness of structural models. Displacement and strain measurement techniques. Theory and practice of indirect model analysis. Theory and practice of direct model techniques, including photo elasticity and moir? methods. Prerequisite(s): [(CAE 503)] (4-0-4)

CAE 523

Statistical Analysis of Engineering Data

Review of probability, random variables, distribution models, estimation of statistical parameters and testing validity of distribution models. Analysis of variance (ANOVA), hypothesis testing, correlation analysis, multiple range tests, pairwise comparisons, data compilation using unconventional sources, such as using simulations, expert opinion and cycle-counting methods.

(3-0-3)

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) OR (CAE 531)] (3-0-3)

CAE 525

Advanced Steel/Composite Structures

Torsion and web openings. Behavior and design of rigid and semi rigid beam-to-column connections and base plates. Inelastic behavior of steel and composite members and systems under severe cyclic loading. Design of steel-concrete composite and hybrid systems. P-delta effect and design considerations for system stability. Design of special and ordinary moment-resisting frames. Design of concentrically and eccentrically braced frames. Design of bracing for stability. Plate girders. Fatigue and fracture.

Prerequisite(s): $[(CAE 431^*)]$ An asterisk (*) designates a course which may be taken concurrently. (4-0-4)

CAE 526

Energy Conservation Design in Buildings

Identification of the optimal energy performance achievable with various types of buildings and service systems. Reduction of infiltration. Control systems and strategies to achieve optimal energy performance. Effective utilization of daylight, heat pumps, passive and active solar heaters, heat storage and heat pipes in new and old buildings.

Prerequisite(s): [(CAE 331) OR (CAE 513)]

(3-0-3)

CAE 527

Control of Building Environmental Systems

Introduction to automatic control systems. Control issues related to energy conservation, indoor air quality and thermal comfort in buildings. Classification of HVAC control systems. Control systems hardware: selection & sizing of sensors, actuators & controllers. Practical HVAC control systems; elementary local loop and complete control systems. Case studies. Computer applications.

Prerequisite(s): [(CAE 513) OR (CAE 531)] (3-0-3)

CAE 528

Building Electrical Systems Design

Study of the analysis and design of electrical systems in buildings utilizing the National Electric Code. Topics include AC, DC, single phase and three-phase circuits, transients, branch circuits, panel boards, system sizing, fault calculations and overcurrent protection design. Also studies the design and specification of emergency power backup and alternative power systems. (3-0-3)

CAE 530

Finite Element Method of Analysis

Covers advanced and special topics in finite element analysis such as finite element-boundary element method, plates, and shell analysis using finite elements and stochastic finite elements.

Prerequisite(s): [(CAE 442)] (3-0-3)

CAE 532

Analysis of Plates & 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 442*) OR (MMAE 501*)] An asterisk (*) designates a course which may be taken concurrently. (4-0-4)

CAE 533

Theory & 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 442*) OR (MMAE 501*)] An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

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 442*) OR (MMAE 501*)] An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

Nonlinear Finite Element Analysis

FEM as applied to nonlinear problems. Contact problems, the mechanics of large deformation, full and updated Lagrange formulations, review of plasticity, solution algorithms, Eulerian approaches, application to FEM to limit analysis. Same as MAE 539.

Prerequisite(s): [(CAE 442) OR (MMAE 501)] (3-0-3)

CAE 537

Homeland Security Concerns in Building Designs

Review of blat 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.

(3-0-3)

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. (3-0-3)

CAE 540

Asphalt & 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. (2-3-3)

CAE 541

Pavement Evaluation & 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.

(3-0-3)

CAE 543

Demand Models 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.

Prerequisite(s): [(CAE 416)] (3-0-3)

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 travel demand and evaluating alternatives in transportation planning. (4-0-4)

CAE 545

Traffic Operations & Flow Theory

Studies of space and time distribution of speed and other traffic characteristics in the transportation network. Macroand micro traffic flow theories. Simulation in traffic systems. Application of flow theories to traffic control and operations. (3-0-3)

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. (3-0-3)

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; accident and safety research.

 $\label{eq:precession} \begin{array}{l} \mbox{Prerequisite(s): } [(CAE \ 419^*)] \ An \ asterisk \ (*) \ designates \ a \ course \ which \ may \ be \ taken \ concurrently. \\ (3-0-3) \end{array}$

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.

Prerequisite(s): [(CAE 419*)] An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

CAE 549

Transportation Economics, Development & 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.

Prerequisite(s): [(CAE 419^{*})] An asterisk (^{*}) designates a course which may be taken concurrently. (3-0-3)

CAE 551

Prestressed Concrete

Theory and design of prestressed concrete members and structure. Applications to both simple and continuous girder and frames subjected to stationary or moving loads. Prestressed cylindrical shells.

Prerequisite(s): $[(CAE 432^*)]$ An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

Measurement & Instrumentation in Architectural Engineering

Experimental statistics & data analysis. Dynamic measurement. Measurement of thermal characteristics (conductivity, diffusivity, etc.). Fluid-property measurement (Pressure, Temperature, etc). Fluid flow measurement (flow, viscosity, etc). Blower door & tracer gas techniques. Duct leakage measurement. (3-0-3)

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 of evaluation of plans and projects, cost-effectiveness, environmental impact assessment.

Prerequisite(s): [(CAE 419^{*})] An asterisk (^{*}) designates a course which may be taken concurrently. (3-0-3)

CAE 560

Plastic Methods

Fundamental concepts of plasticity in the design of steel structures. Principle of plastic hinges. Upper and lowerbound theorems. Alternating plasticity and incremental collapse. Analysis and design of single story and multi-story framed structures.

Prerequisite(s): [(CAE 431* and CAE 503*)] An asterisk (*) designates a course which may be taken concurrently. (4-0-4)

CAE 561

Structural Reliability & 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)] (3-0-3)

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.

Corequisite(s): (CAE 563) Prerequisite(s): [(CAE 323)] (4-0-4)

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. Corequisite(s): (CAE 562) Prerequisite(s): [(CAE 323)]

(1-3-1)

CAE 564

Design of Foundations, Embankments & Earth Structures

Consolidation phenomena, derivation of bearing capacity equations, beams and slabs on soils, piles and pile groups, compaction, earth pressure theories and pressure in embankment, slope stability analyses, retaining structures, embankment design, soil structure interaction during excavation, design of anchors for landslide stabilization and retaining structures and instrumentation.

Prerequisite(s): [(CAE 323 and CAE 457)] (4-0-4)

CAE 565

Rock Mechanics & 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)]

(4-0-4)

CAE 566

Earthquake Engineering & Soil Dynamics

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

(4-0-4)

CAE 567

Physiochemical Behavior of Soils

The nature of soils. Weathering and soil formulation processes. Soil mineralogy. Surface and colloidal chemistry. Structures of water near clay mineral surfaces. Electrolyte solutions. Theories of cation and anion exchange. Adsorption of inorganic chemicals in soils. Organic matter in soils. Adsorption of organic chemicals in soils. Methods to determine petroleum products in soils. Effect of contaminants on permeability of clays. Leachate-clay liner compatibility. Prerequisite(s): [(CAE 323 and ENVE 501)]

(3-0-3)

CAE 568

Transportation Asset Management Processes and techniques for managing the preservation and expansion of highway transportation facilities such as pavements, bridges, and so forth, as well as system usage. Five component management systems are first examined: pavements, bridges, roadway maintenance, safety, and congestion. Finally, the methodology for overall transportation asset management is discussed. The primary emphasis is on data collection, life-cycle cost analysis, priority setting and optimization, program development strategies, risk and uncertainty modeling, and institutional issues. Prerequisite(s): [(CAE 419)]

(3-0-3)

Legal Issues in Civil Engineering

Basics of legal system, including contracts, torts, land zoning and property ownership. Working knowledge of the law to avoid and mitigate potential legal problems that frequently occur in construction. Contractor liability. Mechanics liens, litigation and arbitration. International construction law, hazardous waste issues and labor law. Prerequisite(s): [(CAE 473)]

(3-0-3)

CAE 571

Lean Construction & Control

This course introduces civil engineering students to LEAN principles and the LEAN project delivery system (LPDS). The LEAN philosophy emphasizes the following: (1) performance improvement rather than productivity improvement by promoting superior reliability (i.e., keeping commitments); (2) customer value and value stream mapping which involves understanding what the customer places value on and establishing the flow of activities that will add value and eliminate waste to the construction cycle; (3) significantly improved processes for flawless coordination, organizing project processes as a production system, and establishing the project as a "collective enterprise" rather than independent efforts; (4) close collaboration among all parties combined with optimizing the whole project rather than optimizing each task or each trade; (5) pull scheduling techniques including a comprehensive process of developing the master schedule, phase schedule, look-ahead schedule, weekly work plan, constraints log/analysis, and measurement of percent plan complete; (6) tools and measurement techniques for managing projects under the LEAN philosophy including reasons analysis, first run studies, value stream mapping, and Kaizen methods; and (7) delivering projects under the LEAN philosophy including contracting methods and integrated project delivery. (3-0-3)

CAE 572

Construction Cost Accounting & Control

Review of basic accounting principles and techniquespurchasing, 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.

(3-0-3)

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.

(3-0-3)

CAE 574

Economic Decision Analysis in Civil Engineering

Basic economic concepts, including interest calculations, computation of alternatives, replacements, depreciation and depletion, and tax considerations. Evaluation of public projects, the effect of inflation, decision making under risk and/or uncertainty, economic decision models. Case studies from the civil engineering industry. (3-0-3)

CAE 575

Systems Analysis in Civil Engineering

Management and system concepts, linear and dynamic programming, system modeling by activity networks. Maximal-flow and shortest-path analysis, flow graphs, decision-tree analysis, stochastic-network modeling, queuing analysis, and analysis of inventory systems. Case studies from the civil engineering industry. (3-0-3)

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. (3-0-3)

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)]

Prerequisite(s): (3-0-3)

CAE 579

Real Estate Fundamentals for Engineers & 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.

(3-0-3)

Intelligent Transportation Systems

A seminar course on Intelligent Transportation Systems (ITS). The concept of 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 years. This course will provide an introduction to the various aspects of ITS and will focus on ITS planning, technology, and evaluation. In addition, such topics as deployment, financing and management are also discussed. The course will include guest lectures and possible field visits.

Prerequisite(s): [(CAE 419) OR (CAE 545)] (3-0-3)

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 techniques 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 traffic assignment problems, and dynamic traffic assignment. Prerequisite(s): [(CAE 419)]

(3-0-3)

CAE 582

Structural Wind & 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 420 and MMAE 406)] (4-0-4)

CAE 583

Special Topics on Earthquake & Wind Engineering Design

This course covers special topics on earthquake and wind design for building and bridge design. The course covers eight topics, one topic per week, as listed in Course Outline. The topics are relatively independent of each other. It is assumed that licensed structural engineers might be able to select any four topics to fulfill their registration requirements, and at the same time learn about current development in the field. (2-0-2)

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)] (3-0-3)

CAE 585

Legal Aspects of Real Estate & Development

The objective of this course is to introduce civil engineering students to the legal aspects of real estate and the real estate development process. Students will learn the fundamentals of land, air, and water rights; legal interests of parties; purchase agreements, contractual relationships, and real estate contracts; closing real estate transactions; legal aspects of financing; government regulations that impact property transactions; and recent developments in green development law. This course will help civil engineering students learn legal skills that can be applied to real estate purchasing and development processes. This course is the second course in a two-course series on real estate and development. The first course is CAE 579: Real Estate Fundamentals, which is taught each fall semester. (3-0-3)

CAE 586

Seismic Design of Building & Bridge Structures

The course covers six topics, as listed in the course outline, on seismic design of steel and R/C building structures and bridges. In addition to offer fundamentals and experiences in seismic design through design examples, it is also assumed that structural engineers who are preparing for their Structural Engineer License Exam might find extremely helpful.

Prerequisite(s): [(CAE 431 and CAE 432)]

(3-0-3)

CAE 589

Groundwater Hydrology & Sampling

Groundwater geology and flow, aquifer and aquitar 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.

Prerequisite(s): [(CAE 301 and CAE 323) OR (ENVE 401)] (3-0-3)

CAE 590

Geotechnical Landfill Design & 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)] (3-0-3)

CAE 591

Research & Thesis for M.S. Degree

Research and Thesis for M.S. Degree (Credit: Variable)

CAE 593

Civil Engineering Seminar Reports on current research. Graduate students are expected to register and attend. (1-0-0)

CAE 594

Research Problems Research problems. (Credit: Variable)

CAE 597 Special Probl

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 599

Graduate Workshop.

(0-0-0)

CAE 691

Research & 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. (2-0-2)

CAE 770

Legal Issues in Construction Management

Legal issues in construction management. (3-0-3)

CAE 778

International Contracting International contracting. (2-0-2)

Environmental Engineering

ENVE 501

Environmental Chemistry

Chemical processes in environmental systems, with an emphasis on equilibrium conditions in aquatic systems. The types of 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. Core Course.

(3-0-3)

ENVE 506

Chemodynamics

The dynamics of pollutant transfer in biogeochemical systems of the earth. The overall objective of this course is to introduce fundamental science and engineering principles needed 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. Core course. (3-0-3)

ENVE 509

Special Topics in Environmental Chemistry

Lectures and field studies on topics pertinent to the chemical aspects of environmental systems. May be repeated with change of course content up to a maximum of six credits. (Credit: 1-3 hours.)

(Credit: Variable)

ENVE 512

Special Topics in Environmental Biology

Selected laboratory techniques pertinent to the biological aspects of environmental engineering. May be repeated with change of course content up to a maximum of six credits. (Credit: 1-3 hours) (Credit: Variable)

ENVE 513

Biotechnological Processes in Environmental Engineering

Fundamentals and applications of biological mixed culture processes for air, water, wastewater, and hazardous waste treatment. Topics include biochemical reactions, stoichometry, enzyme and microbial kinetics, detoxification of toxic chemicals, and suspended growth and attached growth treatment processes. The processes discussed include activated sludge process and its modifications, biofilm processes including trickling filters and biofilters, nitrogen and phosphorous removal processes, sludge treatment processes including mesophilic and thermophilic systems, and natural systems including wetlands and lagoons. (3-0-3)

ENVE 520

Environmental Monitoring & Assessment

Modeling and monitoring methods for the prediction and assessment of environmental impacts due to changes in the physical, chemical and biological environment. Comparative studies of methodologies to assess immediate and extended effects, including trends in space and time due to changes in anthropogenic systems. Dynamics of environmental changes, inventory methods and priority impact criteria. Same as ENVE 405. (3-0-3)

ENVE 527

Statistical Analysis of Systems

Multivariate probability distributions. Inference about mean, variance. Multivariate linear regression and response surface analysis. Principal components analysis, factor analysis, canonical correlation and analysis. Clustering, discrimination and classification. Selected advanced topics such as survey design, design of experimental techniques, statistical methods for discrete and binary variables, time series analysis partial least squares techniques.

Prerequisite(s): [(ENVE 426*)] An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

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. (3-0-3)

ENVE 532

Special Topics in Environmental Engineering

Lectures and discussion on topics pertinent to the engineering aspects of environmental systems. May be repeated with change of course up to a maximum of six credits. (Credit: 1-3 hours)

(Credit: Variable)

ENVE 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 practioners 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. (3-0-3)

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.

Prerequisite(s): [(ENVE 501*)] An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

ENVE 544

Energy, Environment & Economics

The linkage of energy, environmental and economic issues. The impact of energy supply and end use on human wellbeing and the ecosystem. A comprehensive approach to the resolution of resource, technical, economic, strategic, environmental, socio- and geo-political problems of the energy industries. Pathways to a sustainable global energy system. (3-0-3)

ENVE 545

Environmental Regulations & Risk Assessment

One third of the course is a review of current environmental regulations, including the Clean Air Act, Clean Water Act, Toxic Substances Control Act, Resource Conservation and Recovery Act, CERCLA and the Pollution Prevention Act. The rest of the course deals with the fundamentals of risk assessment, including hazard identification, dose-response assessment, exposure assessment and risk characterization for public health and ecosystems. (3-0-3)

ENVE 546

Industrial Hygiene

An introduction to toxicology, exposure routes and physiological classification of toxicants. Epidemiological considerations, measurement methods, strategies and calculations. Modeling of exposures and evaluation of controlling parameters. Ventilation methods of control. Physical stressors of sound, heat, vibration and lifting. Methods for measurement and calculation of exposure/compliance levels. (3-0-3)

ENVE 551

Industrial Waste Treatment

Industrial waste sources and characteristics, significance of industrial waste as environmental pollutants; applications of standard and special treatment processes, including physical, chemical and biological systems.

Prerequisite(s): [(ENVE 513*) OR (ENVE 542*)] An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

ENVE 561

Design of Environmental Engineering Processes

Design of water and wastewater treatment systems. System economics and optimal design principles.

Prerequisite(s): [(ENVE 513*) OR (ENVE 542*)] An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

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. Core Course. (3-0-3)

ENVE 572

Ambient Air Monitoring

Ambient air sampling and pollutant analysis. Methods for collection and identification of gaseous and particulate pollutants. Air monitoring survey design, instrument calibration, interpretation of atmospheric data.

Prerequisite(s): [(ENVE 501* and ENVE 570*)] An asterisk (*) designates a course which may be taken concurrently. (2-3-3)

ENVE 574

Stack Sampling & Analysis

Current practices of measuring pollutants emitted from stationary sources. Methods of collection and analysis of stack effluents, including field sampling techniques and data evaluation.

(2-3-3)

ENVE 576

Indoor Air Pollution

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

Prerequisite(s): [(ENVE 405) OR (ENVE 520)] (3-0-3)

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. (3-0-3)

ENVE 578

Physical & 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.

(3-0-3)

ENVE 580

Hazardous Waste Engineering

Sources and characteristics of hazardous wastes, legal aspects of hazardous waste management, significance of hazardous wastes as air, water and soil pollutants. Principles and applications of conventional and specialized hazardous waste control technologies.

Prerequisite(s): [(ENVE 506*)] An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

ENVE 585

Groundwater Contamination & Pollutant Transport

Applications of groundwater flow principles, transport phenomena, and chemical and biological processes to problems of groundwater contamination. Simulation model and case studies of current topics. (3-0-3)

ENVE 590

Environmental Engineering Seminar

Presentations on recent developments in the field by academic and industrial visitors (1-0-0)

ENVE 591

Research & Thesis M.S. Research and thesis writing. (Credit: Variable)

ENVE 597

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

ENVE 691 Research & Thesis Ph.D.

Research and thesis writing. (Credit: Variable)

Department of Computer Science

Stuart Building 10 W. 31st St. Chicago, IL 60616 312.567.5150 312.567.5067 fax www.iit.edu/csl/cs info@cs.iit.edu Chair: Xian-He Sun	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 in- clude formalization and abstraction, algorithm design, programming, organization of unstructured knowledge, modeling, language development, and software system architecture and design. The graduate program in com-	
Associate Chair: Cynthia Hood Bogdan Korel	puter science at IIT 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.	
Degrees Offered		
Master of Computer Science (MAS) Master of Computer Science with specialization in: • Business • Computational Intelligence • Computer Networking and Telecommunications	 Education Finance Information Security and Assurance Information Systems Software Engineering 	

- · Cyber-Physical Systems
- · Data Analytics
- · Distributed and Cloud Computing

Joint- and Dual- Degree Programs

With the Department of Electrical and **Computer Engineering:**

Master of Telecommunications and Software Engineering

Certificate Programs

Computational Intelligence Cyber-Physical Systems Computer Networking and Telecommunications Data Analytics Distributed and Cloud Computing

Research Facilities

The department has research computing facilities that include several state of the at computer clusters and workstations. The equipment includes a large-scale Sun "ComputerFarm" consisting of 172 processors and 562 cores connected via a Linux-based IBM cluster, an Opteron cluster from Microsoft, and a Cray XD1 connected Management. An advanced technology Access Grid node has been installed by the department, which

allows researchers, teachers, and students at different locations worldwide too interact via a network multimedia environment. Research in Data-Intensive Distributed Systems is facilitated by a 12-node cluster with 118 cores, 382 GB RAM, and 32TB of harddisk space. Research labs in the department have advanced computer workstations with multicore servers.

Master of Science in Computer Science

Biological Engineering:

Information Security and Assurance

Chemical Engineering

Information Systems

Software Engineering

Doctor of Philosophy in Computer Science

With the Department of Chemical and

Master of Science in Computer Science/ Master of

Research Areas

Algorithms, data structures, artificial intelligence, computer architecture, computer graphics, computer networking and telecommunications, computer vision, database systems, distribued and parallel processing, I/O

systems, image processing, information retrieval, natural language processing, software engineering, and system software, machine learning, cloud computing.

Faculty

Agam, Gady, Associate Professor. B.S., M.S., Ph.D., Ben-Gurion University (Israel). Computer vision, computer graphics, image processing, pattern recognition, machine learning, geometric modeling, medical imaging, document imaging.

Argamon, Shlomo, Associate Professor. B.S. Carnegie-Mellon University; M.S, Ph.D. Yale University. Machine Learning, computational linguistics, stylistics, information retrieval.

Bauer, Charles, Professor Emeritus. B.S., M.Ed., Loyola University. Computer Education, computers used in education, distance learning, computer-based educational technology, computer learning, teacher training.

Bauer, Matthew J., Senior Lecturer, Director of Undergraduate Computer Science Programs, Associate Dean for Academic Affairs, College of Science and Letters, and Director of Undergraduate Academic Advising. B.S., M.S., Illinois Institute of Technology.

Beckman, Jr., A. Mattox, Senior Lecturer. B.S., Ph.D., University of Illinois, Urbana-Champaign.

Bilgic, Mustafa, Assistant Professor. B.S., University of Texas; M.S., Ph.D., University of Maryland. Data mining, machine learning, probabilisic graphical models, statistical relational learning, active learning, social network analysis, information visualization.

Burnstein, Ilene, Professor Emerita. B.S., Brooklyn College; M.S., University of Maryland; Ph.D., Illinois Institute of Technology. Software engineering, knowledge-based testing and debugging tools, test process assessment and improvement models, capability maturity models.

Calinescu, Gruia, Associate Professor. M.S., University of Bucharest (Romania); Ph.D., Georgia Institute of Technology. Algorithms, approximation algorithms, optical and wireless, ad-hoc networks.

Chlebus, Edward, Industry Associate Professor. M.S., Ph.D., Cracow University (Poland). Network modeling, performance evaluation and tele-traffic analysis.

Evens, Martha, Professor Emerita. A.B., Bryn Mawr College; A.M., Radcliffe College; Ph.D., Northwestern University. Natural language processing, expert systems and intelligent tutoring/information systems.

Glavic, Boris, Assistant Professor. M.Sc., RWTH Aachen University (Germany); Ph.D., University of Zurich (Switzerland).

Greene, Peter, Professor Emeritus. A.B., Amherst College; Ph.D., University of Chicago. Neural networks, feeling-based reasoning, artificial intelligence and robotics.

Hanrath, Jon, Senior Instructor. Ph.D., Michigan State University.

Hood, Cynthia, Associate Professor of Computer Science and Engineering and Associate Chair, Department of Computer Science. B.S., Rensselaer Polytechnic Institute; M.S., Stevens Institute of Technology; Ph.D., Rensselaer Polytechnic Institute. Network management, statistical signal processing, learning processing.

Kapoor, Sanjiv, Professor. Ph.D., University of Illinois, Urbana-Champaign. Computational geometry, graph algorithms, combinatorial optimization, graphics, data structures.

Korel, Bogdan, Associate Professor of Computer Science and Engineering and Associate Chair, Department of Computer Science. M.S., Technical University of Kiev (Ukraine); Ph.D., Oakland University. Software engineering, automated software testing and analysis.

Koutsogiannakis, George, Instructor. B.S., M.S., M.B.A., DePaul University; M.S. Illinois Institute of Technology.

Lan, Zhiling, Associate Professor. B.S. Beijing Normal University (China); M.S. Chinese Academy of Sciences; Ph.D., Northwestern University. Parallel and distributed computing, performance analysis and modeling.

Leung, Wu-Hon F., Industry Professor. Ph.D., University of California-Berkeley.

Li, Xiang-Yang, Professor. B.E., Tsinghua University; M.S., Ph.D., University of Illinois, Urbana-Champaign. Algorithm design and analysis, system design for wireless ad hoc and sensor networks, network information theory, security protocols, and computational geometry.

Raicu, Ioan, Assistant Professor. B.S., M.S., Wayne State University; M.S., Ph.D., University of Chicago. Distributed Systems, high-throughput and highperformance computing, efficient task dispatch and execution systems, resource provisioning, data management, scheduling, performance evaluations in distributed systems.

Reingold, Edward M., Professor. B.S., Illinois Institute of Technology; M.S., Ph.D., Cornell University. Analysis of algorithms, data structures, combinatorial algorithms, mathematics, history, and computer implementation of calendars.

Ren, Shangping, Associate Professor. Ph.D., University of Illinois, Urbana-Champaign. Domain specific computing (including distributed computing, realtime computing, and mobile computing), and domain specific programming abstractions (such as language abstractions for real-time systems, for context-aware adaptive mobile systems, and for coordination among distributed asynchronous entities).

Roberson, Dennis A., Research Professor and Vice Provost for Corporate Relations and Strategic Initiatives. B.S., Washington State University; M.S., Stanford University. Saelee, Michael K., Senior Instructor. B.S., M.S., Illinois Institute of Technology.

Sasaki, James T., Senior Lecturer and Director of the Professional Master's Program. B.S., Illinois Institute of Technology; M.S., Ph.D., Cornell University.

Soneru, Marius D., Senior Lecturer. Ph.D., Illinois Institute of Technology.

Sun, Xian-He, Professor and Chair. Ph.D., Michigan State University. Distributed and parallel processing, software systems, I/O systems, peformance evaluation, scientific computing.

Wan, Peng-Jun, Professor. B.S., Tsinghua University (China); Ph.D., University of Minnesota. Interconnection design, routing and resource management in optical networks, low-earth orbit satellite networks, wireless local area networks.

Winans, Vida J., Senior Instructor and Graduate Coordinator. B.A., Cornell University; M.S., Illinois Institute of Technology.

Zhang-Sun, Hong, Research Professor. B.S., Beijing Normal University; M.S., Ph.D., Michigan State University.

Admission Requirements

Cumulative undergraduate GPA minimum: 3.0/4.0 Cumulative Master of Science GPA minimum (for Ph.D. applicants): 3.5/4.0

GRE minimum combined (quantitative/verbal/analytical) score for tests taken on or after Oct.1, 2011:

M.S.: 298 (quantitative + verbal), 3.0 analytical writing M.A.S.: 292 (quantitative + verbal), 2.5 analytical writing

Ph.D.: 304 (quantitative + verbal), 3.5 analytical writing, with a minimum in the 70th percentile of the quantitative section

GRE minimum score for tests taken on or after Aug.1, 2002:

M.S.: 1000 (quantitative + verbal) 3.0 analytical writing MAS: 900 (quantitative + verbal) 2.5 analytical writing

Ph.D.: 1100 (quantitative + verbal) 3.5 analytical writing, with a minimum in the 70th percentile of the quantitative section

TOEFL score (international students from non-English speaking countries): $523/70^*$

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 masters degree programs in computer science should hold a bachelors degree in computer science with a minimum overall GPA of 3.0/4.0 or its equivalent. For international students from non-English speaking countries, a minimum TOEFL score of 550/213 is required. All applicants must submit scores from the GRE general test. (The GRE requirement is waived for applicants to the Master of Computer Science program who hold bachelors degrees from accredited U.S. institutions with a minimum cumulative GPA of 3.0/4.0.) Applicants with bachelors degrees in other disciplines can be admitted to Master of Science or Master of Computer Science programs. However, students whose training does not include the equivalent of CS 201 (Accelerated Introduction to Computer Science), CS 330 (Discrete Structures), CS 331 (Data Structures and Algorithms), CS 350 (Computer Organization and Assembly Language Programming) and CS 351 (Systems Programming) will be required to complete all of the courses in which a deficiency exists. Some students may be able to complete their deficiencies with the following six-credit hour sequence with grades of "B" or better.:

CS 401 Introduction to Advanced Studies I CS 402 Introduction to Advanced Studies II

In addition, students who have not had at least one course in calculus will be required to take a calculus course.

Applicants to the Ph.D. program should hold an M.S. degree in computer science with a minimum GPA of 3.0/4.0 for their bachelors degree and 3.5/4.0 for their M.S. degree, or a minimum GPA of 3.5/4.0 for their bachelors degree if they apply without a M.S. degree. For non-English speaking applicants without a U.S. degree, a minimum TOEFL score of 550/213 is required.

 \ast Paper/internet-based test score.

Master of Computer Science

30 credits.

This Professional Master's degree program consists of 30 credit hours of coursework in computer science. This program is designed for those without a prior degree in computer science, or those who are primarily interested in a (non-thesis) program preparing them for careers as working computer science professionals in business and industry. A full-time student enrolled in the program should be able to complete the requirements in 1 to 1.5 years. Specializations in business, software engineering, networking and telecommunications and information systems are available. Admission requirements include:

Bachelor's degree from an accredited university with a minimum cumulative GPA of at least 3.0/4.0. Combined verbal and quantitative GRE examination score of at least 900 and an analytic writing score of at least 2.5, for the post-October 2002 test. The GRE requirement is waived for students with a bachelor's degree from an accredited college or university in the United States with a cumulative GPA of at least 3.0/4.0.

Prerequisites include knowledge of a high level programming language at the level of CS 201 (Java or C/C++ programming is required). Students with insufficient background in computer science will be required to take CS 401 and CS 402 (Introduction to Advanced Studies I and II) and to earn at least a B in these courses. These prerequisite courses do not count toward the 30 credithour requirement.

A maximum of 12 credit hours of 400-level courses and a maximum of 6 credit hours of accelerated courses are allowed as part of the 30 credit hours requirement. Twenty hours of coursework must be in CS or CSP (CS Professional) courses at the 500 level.

Students are required to take at least one course in each of the three core areas (Programming, Systems, and Theory).

Programming Core Courses

- CS 511 Topics in Computer Graphics
- ${\rm CS}~512 \ \ {\rm Computer} {\rm \ Vision}$
- CS 525 Advanced Database Organization
- CS 540 Syntactic Analysis of Programming Languages
- CS 546 Parallel Processing
- CS 551 Operating System Design and Implementation
- CS 553 Cloud Computing

Systems Core Courses

- CS 542 Computer Networks I: Fundamentals
- CS 544 Computer Networks II: Network Services
- CS 547 Wireless Networking
- CS 550 Advanced Operating Systems
- CS 555 Analytic Models and Simulation of Computer Systems
- CS 570 Advanced Computer Architecture
- CS 586 Software Systems Architecture

Theory Core Courses

- CS 530 Theory of Computation
- CS 533 Computational Geometry
- CS 535 Design and Analysis of Algorithms
- CS 536 Science of Programming
- CS 538 Combinatorial Organization

Master of Science in Computer Science/Master of Chemical Engineering

44 credit hours

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

Students must fulfill the core course requirements of both departments. Students are required to take 18 credit hours in graduate chemical engineering courses (courses numbered 500 or higher) and 26 credit hours in computer science courses (of which 20 credit hours must be 500- level courses). The 18 credit hours in chemical engineering courses consist of 12 credits in core courses listed in the description of the Master of Chemical Engineering requirements and six credit hours from the following courses:

- CHE 507 Computer-Aided Design
- CHE 508 Process Design Optimization
- CHE 528 Analysis and Simulation of Chemical Processing
- CHE 532 Process Modeling
- CHE 533 Statistical Analysis Of Systems
- CHE 536 Computational Techniques in Engineering
- CHE 560 Statistical Quality and Process Control

Master of Computer Science with Specialization in Business

33 credit hours

Specialization Courses

This program is designed to help computer science pro-
fessionals extend and deepen their technical and practical
knowledge of the field while introducing themselves to
core topics in modern business practices. To complete
the program students must satisfy Master of Computer
Science requirements and also take four specialization
courses from the Stuart School of Business:

•	
BUS 510	Building an Innovative & Sustainable
	Business
BUS 550	Business Analytics for Competitive
	Advantage
MBA 501	Accounting for Strategic Decision Making
MBA 502	Emerging Issues in the Global Business
	Environment
MBA 504	Spreadsheet Modeling
MBA 506	Leading & Managing Knowledge-Intensive
	Organizations
MBA 509	Financial Management in a Globalized
	World
MBA 511	Creating, Communicating & Delivering
	Customer Value

Note: Stuart School of Business tuition and fees apply to these courses. Applicants to the program are not required to take the GMAT.

Master of Computer Science with Specialization in Computational Inteliligence

30 Credit Hours

This program is intended for students who are interested in ways in which computers may learn and adapt based on data so as to solve complex problems in various areas of computer science.

To qualify for the specialization in Computational Intelligence, students must satisfy general Master of Computer Science requirements and are also required to select our fo the following specialization courses.

Specialization Courses

- CS 512 Computer Vision
- CS 522 Data Mining
- CS 583 Probabilistic Graphical Models
- CS 584 Machine Learning
- CS 585 Natural Language Processing

With department approval, a course not on the list above may be substituted for one of the five specialization courses.

Master of Computer Science with Specialization in Cyber-Physical Systems

30 Credit Hours

This program is intended for students who are interested in leraning how to work with embedded controllers with integrated sensors and networking abilities and t utilize them for real-world applications.

To qualify fo the specialization in Cyber-Physical systems, students must satisfy general Master of Computer Science requirements and are also required to select four of the following specialization courses.

Specialization Courses

- CS 442 Mobile App Development
- CS 552 Distributed Real-Time Sytems
- CS 553 Cloud Computing
- CS 555 Analytic Models and Simulation of Computer Systems
- CS 556 Cyber-Physical Systems: Languages and Systems
- CS 557 Cyber-Physical Systems: Networking and Algorithms

Master of Computer Science with Specialization in Computer Networking and Telecommunications

30 credit hours

This program is designed to provide an in-depth knowledge of the theories and practices in computer networking and telecommunications. Students must satisfy Master of Computer Science requirements and are also required to select four specialization courses. Note that CS 542, CS 544, and CS 547 also count as Systems core courses.

Specialization Courses

- CS 542 Computer Networks I: Fundamentals
- CS 544 Computer Networks II: Network Services
- CS 547 Wireless Networking
- CS 548 Broadband Networks
- CS 549 Cryptography and Network Security
- $\begin{array}{cccc} {\rm CS} \ 555 & {\rm Analytic} \ {\rm Models} \ {\rm and} \ {\rm Simulation} \ {\rm of} \ {\rm Computer} \\ {\rm Systems} \end{array}$
- CS 557 Cyber-Physical Systems Networking and Algorithms

Master of Computer Science with Specialization in Data Analytics

30 Credit Hours

Intelligent analysis of large amounts of data is a crucal component in supporting business decisions. The Master of Science with Specialization in Data Analytics is intended for students interested in learning how to discover patterns in large amounts of data in information systems and how to use these to draw conclusions.

To qualify for the specialization in Data Analytics, students must satisfy general Master of Computer Science requirements and are also required to select four of the follwing specialization courses.

- Specialization Courses
- CS 422 Data Mining
- CS 522 Advanced Data Mining
- CS 583 Probabilistic Graphical Models
- CS 584 Machine Learning
- ${\rm CS}~585~~{\rm Natural}~{\rm Language}~{\rm Processing}$
- CS 595 Data Intensive Distributed Computing
- $\begin{array}{c} {\rm CS} \ 557 \\ {\rm Cyber-Physical} \ {\rm Systems} \ \text{-} \ {\rm Networking} \ {\rm and} \\ {\rm Algorithms} \end{array}$

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 abot distributed systems and how they are aplied to real world problems, as well as how emerging cloud computing technologies can be used to implement some of the worlds most popular services and applications.

To qualify for the specialization in Distributed and Cloud Computing, students must satisfy general Master of Computer Science requirements and are also required to select four of the following specialization courses. Below, CS 550 is also marked (Sys), because it also counts as a Systems core course.

Specialization Courses

- CS 546 Parallel and Distributed Processing
- CS 550 Advanced Operating Systems (Sys)
- CS 552 Distributed Real-Time Systems
- CS 553 Cloud Computing
- CS 570 Advanced Computer Architecture
- CS 595 Data-Intensive Distributed Computing

Master of Computer Science with Specialization in Education

33 Credit Hours

The Master of Computer Science with a specialization in Education is designed to enable Computer Science students to further their technical educationwhile opening a career path toward teaching computer science.

Courses for the MCS/Education degree program are taken from the Computer Science Department and the Department of Mathematics and Science Education (MSED). In addition to satisfying General MCS degree requirements, the program of study must include 24 credit hours of CS/CSP courses and the following 3 MSED courses, which are the first 3 required courses for a teaching certificate.

MSED Required Courses

MSED 300	Instructional Methods/Strategies I
MSED 500	Analysis of Classrooms II (Practicum and
	Seminar)

MSED 554 Middle Level and Secondary Science Curriculum

OR

MSED 555 Middle Level and Secondary Mathematics Curriculum

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 Computer Science Department and the Department of Finance in the IIT Stuart School of Business. In addition to satisfying the General MCS Degree requirements, the program of study must include 24 credit hours of CS/CSP courses and the following 3 MSF courses (9 credit hours).

Finance Required Courses

MSF 504 Valuation and Portfolio Management MSF 505 Futures, Options, and OTC Derivatives MSF 506 Financial Statement Analysis

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 cna be accessed from nearly everywhere. The Master of Compuer Science with Specilization in Information Security and Assurance is intended for students interested in aspects of security and assurance in modern e-commerce applications.

To qualify for the specialization in Information Security

and Assurance, students must satisfy general Master of Computer Science requirements and are also required to select four of the following specialization courses:

Specialization Courses

- CS 458 Introduction to Information Security
- CS 525 Advanced Database Organization
- CS 549 Cryptography and Network Security
- CS 595 Information Security, Privacy, and Assurance
- CS 553 Cloud Computing
- CS 570 Advanced Computer Architecture

Master of Computer Science with Specialization in Information Systems

 $30~{\rm credit}$ hours

This program is designed to provide in-depth knowledge of the principles of design and development of information systems. Students must satisfy Master of Computer Science requirements and are also required to select four specialization courses. Note that CS 522, CS 525, and CS 529 also count as Programming core courses

Specialization Courses

- CS 521 Object-Oriented Analysis and Design
- CS 522 Data Mining
- CS 525 Advanced Database Organization
- CS 529 Information Retrieval
- CS 545 Distributed Computing Landscape

Master of Computer Science with Specialization in Software Engineering

30 credit hours

This program is designed to provide an in-depth knowledge of theory and practices in software engineering, including hands-on experience in software design, development and maintenance. Students must satisfy Master of Computer Science requirements and are also required to select four specialization courses. Note that CS 536 and CS 586 also count as Theory and Systems core courses respectively.

CS 536 Science of Programming

CS 537 Software Metrics

Specialization Courses

- CS 586 Software System Architectures
- CS 587 Software Project Management
- CS 588 Advanced Software Engineering Development
- CS 589 Software Testing and Analysis

Master of Science in Computer Science

32 credit hours

The purpose of this program is to prepare students for the Ph.D. program and/or a research/development career in the industry in the field of computer science. Students have the option to pursue thesis research or project under the guidance of a faculty advisor.

Program Requirements

All programs require a core curriculum of 12 credit hours and 20 credit hours of elective courses, which may include a thesis or project. If a thesis or project is included in the program, the student, with a faculty advisor, develops a program of study that specifies the supportive and elective program and describes the thesis or project. The program of study must consist of at least 32 credit hours, at least 20 of which must be 500-level computer science courses. Up to six credits of accelerated courses may be applied to the degree. (Students should see the definition of "accelerated courses" below.)

A student may choose from three options to complete the degree:

- Option 1: Master's thesis: Coursework and up to five hours of CS 591 for a total of 32 hours. The result is a master's thesis.
- Option 2: Master's project: coursework and up to five hours of CS 597 for a total of 32 hours. The result is a project that results in one of the following:
 - 1. A high-quality paper submitted for publication as an article or as a technical report.
 - 2. A high-quality piece of software. The software should be of distribution quality, but can be proprietary.

Option 3 32 credit hours of coursework. A student must complete 32 hours of regular coursework including electives and core courses with a GPA of 3.0/4.0 or better.

Students are required to take courses in three core areas: Programming, Systems, and Theory. The student is required to take at least one course from the Programming area, at least one course from the Systems area, and at least two courses from the Theory area. The list below contains the core course offerings in the M.S. program:

Programming Core Courses

- CS 511 Topics in Computer Graphics
- CS 512 Computer Vision
- CS 525 Advanced Database Organization
- CS 540 Syntactic Analysis of Programming Languages
- CS 541 Topics in Compiler Construction
- CS 546 Parallel Processing
- CS 551 Operating System Design and Implementation
- CS 553 Cloud Computing

Systems Core Courses

- CS 542 Computer Networks I: Fundamentals
- CS 544 Computer Networks II: Network Services
- CS 547 Wireless Networks
- CS 550 Advanced Operating Systems
- CS 555 Analytic Models and Simulation of Computer Systems
- ${\rm CS}~570~~{\rm Advanced}~{\rm Computer}~{\rm Architecture}$
- CS 586 Software Systems Architectures

Theory Core Courses

- CS 530 Theory of Computation
- CS 533 Computational Geometry
- CS 535 Design and Analysis of Algorithms
- CS 536 Science of Programming
- CS 538 Combinatorial Optimization

Master of Telecommunications and Software Engineering (M.T.S.E.)

30 credit hours

The Master of Telecommunications and Software Engineering (M.T.S.E.) is a course-only degree program that prepares students for professional practice in telecommunications and information technologies. The program, jointly offered by the Electrical and Computer Engineering (ECE) and Computer Science (CS) departments, can be completed in one year of full-time study.

Admission Requirements

A person holding a B.S.E.E., B.S.C.P.E. or B.S.C.S. degree has the necessary broad background to undertake the M.T.S.E. program. A student without adequate background in specific areas is required to demonstrate proficiency in prerequisite courses; an abbreviated list is given below.

Specific proficiency courses will be detailed for each student at the time of admission to the M.T.S.E. program. Proficiency in a course may be demonstrated by completing the course with a grade of A or B, or by achieving a grade of A or B in a proficiency examination administered by the ECE or the CS department. Students should contact the departmental advisor for more details on prerequisites and proficiency requirements.

Students interested in the M.T.S.E. degree whose B.S. degree is not in electrical engineering, computer engineering, or computer science should contact the departmental advisor before applying.

Computer Science Prerequisites

CS 201 Accelerated Introduction to Computer Science CS 401 Introduction to Advanced Studies

Electrical and Computer Engineering Prerequisites

ECE 211 Circuit Analysis IECE 213 Circuit Analysis IIECE 308 Signals and SystemsMATH 252 Introduction of Differential Equations

Program Requirement

The M.T.S.E. is a professional master's degree requiring a minimum of 30 credit hours of advisor-approved coursework. The M.T.S.E program of studies must include a minimum of 12 credit hours of ECE coursework and a minimum of 12 credit hours of CS coursework. Four required courses and one elective course from each of the three categories given below must appear on the M.T.S.E. program of studies.

Required Courses

- CS 586 Software Systems Architecture
- CS 587 Software Project Management
- ECE 513 Communication Engineering Fundamentals
- ECE 541 Performance Evaluation of Computer
 - Networks (can be substitued with ECE 542)

Elective Categories

I. Software Engineering

- CS 521 Object-Oriented Information Systems
- CS 537 Software Metrics
- CS 589 Software Testing and Analysis

II. Telecommunication Systems

- CS 544 Computer Networks II: Network Services
- CS 548 Broadband Networks
- CS 555 Analytic Models and Simulation of Computer Systems
- ECE 545 Advanced Communication Networks

III. Telecommunications

ECE 504	Wireless Communication System Design
ECE 515	Modern Digital Communications
ECE 519	Coding for Reliable Communications

The remaining nine credits of coursework may be taken from courses listed above, or other courses approved by the M.T.S.E. advisor. Students with no background in communications or software engineering should consider including in their programs of study:

CS 450 Operating Systems

- CS 455 Data Communications
- CS 487 Software Engineering

ECE 403 Communications Systems

Other courses that students in this program typically choose from include:

ECE 437 Digital Signal Processing I

ECE 511 Analysis of Random Signals

ECE 514 Digital Communication Principles

CS 542 Computer Networks I: Fundamentals

CS 588 Advanced Software Engineering Development

With advisor approval, the M.T.S.E. program can include up to two credit hours of Master's Seminar (ECE 595, ECE 596). It can also include up to four credits of accelerated courses.

Doctor of Philosophy

85 credit hours if without M.S. degree; 54 credit hours if with M.S. degree. Qualifying exam Comprehensive exam Dissertation and oral defense

The Ph.D. is awarded in recognition of a significant original contribution to one of the fields of computer science and a high level of mastery in several fields of computer science and a significant original contribution to one of those fields. Students work with faculty members to develop programs to match individual in-

Requirements for Students Entering With a B.S. Degree

85 credit hours Qualifying exam Comprehensive exam Dissertation and oral defense

Admission Requirements

The Ph.D. (post B.S.) program (called the direct Ph.D. program) encourages bright and highly motivated students to participate in a research program immediately after the B.S. degree.

The applicants should have a B.S degree in computer science. Admission to the program is competitive and depends on a student's GRE score and it is expected that applicants will have a high grade-point average. For

Requirements for Students Entering With an M.S. Degree

54 credit hours Qualifying exam Comprehensive exam Dissertation and oral defense

Admission Requirements

The applicants should have an M.S degree in computer science or related fields. Admission to the program is competitive and depends on a student's GRE score and it is expected that applicants will have a high grade-point average. For non-English speaking applicants without a U.S. degree, a minimum TOEFL score of 550 is required. terests. The goal is to develop computer scientists who can take complex, undefined problems and restructure and resolve them through imaginative application of their knowledge. Graduates typically go on to teaching and/or research positions in industry and universities. The degree normally requires three to four years beyond the master's degree for full-time students. Part-time students can also enter the program but will need more time to complete the degree. Generally, students can enter the program with either a B.S. degree or an M.S. degree in related fields. The requirements of the Ph.D. program are described separately as follows.

non-English speaking applicants without a U.S. degree, a minimum TOEFL score of 550 is required. If the TOEFL score is less than 600, the applicant is required to take the English Proficiency Exam administered by the IIT Humanities Department. Applicants must submit three letters of recommendation.

If the TOEFL score is less than 600, the applicant is required to take the English Proficiency Examination administered by the IIT Humanities Department. Applicants must submit three letters of recommendation.
Doctor of Philosophy - continued

Program Requirements (for students with a B.S. degree)

The program requires students to complete at least 85 and at most 128 advisor-approved semester credit hours of study. This must include

- 0-12 credits of 400-level courses
- 36-54 credits of 500- and 600- level courses. Among them, at most 6 credits come from outside the Computer Science Department of IIT. Credits from CS 595 are allowed.
- 6-12 credits of CS 597 (Reading and Special Problems)
- 24-48 credits of CS 691 (Research/Thesis for Ph.D. degree). Note CS 691 can only be taken after passing the Ph.D. qualifying exam.
- 1 credit of Ph.D. seminar

Notice that no credits will be given to accelerated courses (700-level courses). No credits are given to courses in which the student earns a grade of C or below. The student may have to take some other courses as required by the advisor. The credit hours of 500-level coursework must include five core courses with at least one each from Groups I-III described below and at least one course from each of two different groups from among Groups IV-VII. Advanced courses may be substituted after approval of the department. The groups of core courses are:

Group I: Theory of Computation

- CS 530 Theory of Computation
- CS 533 Computational Geometry
- CS 535 Design and Analysis of Algorithms
- CS 538 Combinatorial Optimization

Group II: Systems

- CS 546 Parallel Processing
- CS 550 Advanced Operating Systems
- CS 570 Advanced Computer Architecture

Group III: Programming Languages

- CS 536 Science of Programming
- CS 541 Topics in Compiler Construction
- CS 545 Distributed Computing Landscape

Group IV: Networks

- CS 542 Computer Networks I: Fundamentals
- CS 544 Computer Networks II: Network Services

Group V: Databases

CS 525 Advanced Database Organization

Group VI: Software Engineering

CS 586 Software Systems Architectures

Group VII: Computational Intelligence

- CS 512 Computer Vision
- CS 583 Probabilistic Graphical Models
- CS 584 Machine Learning
- ${\rm CS}~585~~{\rm Natural}~{\rm Language}~{\rm Processing}$

M.S. Exit from Program

Students wishing to leave the direct Ph.D. program with the degree of Master of Science in Computer Science must satisfy all the requirements of the Master's degree and either write an M.S. thesis or pass the Ph.D. qualifying examination.

Ph.D. Qualifying Examination

The Ph.D. Qualifying Exam has two parts: a written examination and an oral examination. The written examination is used to judge a student's breadth of knowledge; the oral examination is used to judge a student's research potential. The first attempt in oral examination and the written examination must be taken no later than a student's 5th semester. The second attempt must be taken no later than a student's 6th semester. These requirements hold for both full-time and part-time students The written examination is divided into three, independent "area" examinations. To pass the written examination, a student must pass all the area examinations.

Area examinations can be taken in the same or different semesters. A student who fails an area examination can retake the area examination, but only once. Passing a relevant core course with "A" when registered in the PhD section of hat course qualifies as passing the respective area examination. See the computer science webpage for more detail of qualifying examinations.

Comprehensive (Research Proposal) Examination

The purpose of the Comprehensive Examination is to ensure that the candidate has the background to carry out successful research in the chosen area and that the research problem is properly formulated and has sufficient scholarly merit. The student (in concert with the student's research advisor) must develop a written research proposal containing a literature review, a proposed research topic, and a program of research based upon this topic, and then present the proposal orally as well.

The student must request appointment of an examination committee using Form 301. The examination committee may consist of from four to seven members. It must include at least three full-time faculty members from the Computer Science Department and one full-time faculty member from another department in the university Other committee members from inside or outside the university may be chosen. The student should consult with his/her research advisor concerning the makeup of the committee.

Thesis Defense

Each student must present an oral defense of his/her Ph.D. Thesis. The Thesis Review Committee is appointed in much the same way as the Ph.D. Comprehensive Examination Committee. It will examine the written thesis and examine the student during the oral defense. All Ph.D. Thesis Defenses are open to the public.

Doctor of Philosophy - continued

Program Requirements (for students with an M.S. degree)

If the student has an M.S. degree in computer science, the program requires the student to complete at least 54 advisor-approved semester credit hours of study. This must include

- 0-12 credits of 400-level courses
- 18-30 credits of 500- and 600-level courses. Amongst them, at most 6 credits come from outside the computer science department. Credits from CS 595 are allowed.
- 3-12 credits of CS 597 (Reading and Special Problems)
- 24-48 credits of CS 691 (Research/Thesis for Ph.D. degree). Note CS 691 can only be taken after passing the Ph.D. qualifying exam.
- 1 credit of Ph.D. seminar

Notice that no credits will be given to accelerated courses (700-level courses). No credits are given to courses in which the student earns a grade of C or below. The student may have to take some other courses as required by the advisor. The credit hours of 500-level coursework must include three core courses with at least one each from Groups I-III described before. Advanced courses may be substituted after approval of the department.

If the student has an M.S. degree in a field other than computer science, the program requires the student to complete at least 60 advisor-approved semester credit hours of study. This must include:

- 0-12 credits of 400-level courses
- 24-30 credits of 500- and 600-level courses. Among them, at most 6 credits may come from outside the computer science department. Credits from CS595 are allowed.
- 3-12 credits of CS 597 (Reading and Special Problems)
- 24-48 credits of CS 691 (Research/Thesis for the Ph.D. degree). Note CS 691 can only be taken after passing the Ph.D. qualifying exam.
- 1 credit for CS 695 (the Ph.D. seminar)

Notice that no credits will be given to accelerated courses (700-level courses). No credits are given to courses in which the student earns a grade of C or below. The student may have to take some other courses as required by the advisor. The credit hours of 500-level coursework must include five core courses with at least one each from Groups I-III described before and at least two courses from two different groups from among Groups IV-VII. Advanced courses may be substituted after approval of the department.

Ph.D. Qualifying Examination

The Ph.D. Qualifying Examination has two parts: a written examination and an oral examination. The written exam is used to judge a student's breadth of knowledge; the oral exam is used to judge a student's research potential. The first attempt at the oral examination and the written examination must be made no later than a student's 3rd semester. The second attempt must be made no later than a student's 4th semester. These requirements hold for both full-time and part-time students.

The written examination is divided into three, independent "area" examinations. To pass the written examination, a student must pass all the area examinations. Area examinations can be taken in the same or different semesters. A student who fails an area examination can retake the area examination, but only once. Passing a relevant core course with "A" when registered in the PhD section of hat course qualifies as passing the respective area examination. See the computer science web page for more details about the qualifying examinations.

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Certificate Programs

Certificate programs offer working professionals an opportunity to increase their knowledge and skills in the specific areas of computer science. A certificate representing proven academic performance is presented after the required coursework is completed with a GPA of

Computational Intelligence Certificate

Nine hours from the following:

- CS 512 Computer Vision
- CS 522 Data Mining (pgm)
- ${\rm CS}~583 \quad {\rm Probabilistic}~{\rm Graphical}~{\rm Models}$
- CS 584 Machine Learning
- CS 585 Natural Language Processing

Computer Networking and Telecommunications Certificate

Nine hours from the following:

- CS 455 Data Communications
- CS 542 Computer Networks I: Fundamentals
- CS 544 Computer Networks II: Network Services
- CS 548 Broadband Networks

Cyber-Physical Systems Certificate

Nine hours from the following:

- CS 442 Mobile App Development
- CS 552 Distributed Real-Time Systems
- CS 553 Cloud Computing
- CS 555 Analytic Models and Simulation of Computer Systems
- CS 556 Cyber-Physical Systems: Languages and Systems
- CS 557 Cyber-Physical Systems: Networking and Algorithms

Data Analytics Certificate

Nine hours from the following:

- CS 422 Data Mining
- CS 522 Advanced Data Mining
- CS 583 Probabilistic Graphical Models
- CS 584 Machine Learning
- CS 585 Natural Language Processing
- CS 595 Data-Intensive Distributed Computing

3.0/4.0. Courses taken may be later applied toward an M.S. degree program. Applicants should have a bachelors degree from an accredited college or university. The degree need not be in computer science.

Distributed and Cloud Computing Certificate

Nine hours from the following:

CS 546 Parallel and Distributed Computing CS 550 Advanced Operating Systems (sys) Distributed Real-Time Systems CS 552CS 553Cloud Computing CS 570Advanced Computer Architecture CS 595 Data-Intensive Distributed Computing

Information Security and Assurance Certificate

Nine hours from the following:

CS 458 Introduction to Information Security CS 525 Advanced Database Organization CS 549 Cryptography and Network Security CS 595 Information Security, Privacy, and Assurance CSP 544 System and Network Security

Information Systems Certificate

Nine hours from the following:

CS 425 Database Organization Object-Oriented Analysis and Design CS 521CS 525 Advanced Database Organization

Software Engineering Certificate

Nine hours from the following: CS 445 Object-Oriented Design and Programming CS 487 Software Engineering CS 537Software Metrics CS 586 Software Systems Architecture

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 proCS 587 Software Project Management

- CS 588 Advanced Software Engineering Development
- CS 589 Software Testing and Analysis Computer-Aided Software Engineering CS 750
- CS 763 Automated Software Testing

vide an opportunity for degree-seeking students at IIT to complete M.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. degree at IIT.

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)] (3-0-3)

CS 512

Topics in 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)] (3-0-3)

CS 520

Database Design & Engineering

Overview of database architectures, including the Relational, Hierarchical, Network, and Object Models. Database normalization and design. Implementation issues for database management systems, including the processing and parsing of SQL queries, query optimization, integrity, and concurrency control. Distributed and parallel databases and data warehouse issues are addressed. Solid programming skills are required. Implementation of a database management engine prototype is required. No credit is given for both this course and CS 425.

Prerequisite(s): [(CS 351) OR (CS 402 and CS 430)] (3-0-3)

CS 521

Object-Oriented Analysis & Design

This course describes a methodology that covers a wide range of software engineering techniques used in system analysis, modeling and design. These techniques integrate well with software process management techniques and provide a framework for software engineers to collaborate in the design and development process. The methodology features the integration of concepts, including software reusability, frame works, design patterns, software architecture, software component design, use-case analysis, event-flow analysis, event-message analysis, behavioral-life cycle analysis, feature, multiple-product, risk and rule analysis, and automatic code generation. (Credit will not be given for CS 521 if CS751 is taken)

Prerequisite(s): [(CS 445) OR (CS 487)] (3-0-3)

CS 522

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)] (3-0-3)

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)]

(3-0-3)

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)] (3-0-3)

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)] (3-0-3)

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)] (3-0-3)

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)] (3-0-3)

CS 535

Design & 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)]

(3-0-3)

CS 536

Science of Programming

Formal specification of how programs execute operational semantics , how mathematical functions programs compute denotational semantics , and how to use logic to characterize properties and invariants of the program execution (axiomatic semantics).

Prerequisite(s): [(CS 331) OR (CS 401)] (3-0-3)

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)]

(3-0-3)

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)] (3-0-3)

(3-0-3)

CS 539

Game Theory: Algorithms & Applications

This course focuses on computational issues in the theory of games, economics, and network design. Interest in the algorithmic aspects of games is motivated by the computational issues of fundamental aspects of games and economic theory, e.g. Nash equilibrium and market equilibrium. Computing and approximating Nash equilibrium will be studied. Of considerable interest to the computer science community are problems that arise from the Internet and computer networks and are similar to issues that arise in traditional transport networks, e.g. Wardrop equilibrium. Prerequisite(s): [(CS 430) OR (CS 530)] (3-0-3)

CS 540

Syntactic Analysis of Programming Languages

Formal definition of syntax with emphasis on contextfree 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)] (3-0-3)

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)] (3-0-3)

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)]

(3-0-3)

CS 544

Computer Networks II: Network Services

Qualitative and quantitative analysis of networks. A combination of analytical and experimental analysis techniques will be used to study topics such as protocol delay, end-to-end network response time, intranet models, Internet traffic models, web services availability, and network management.

Prerequisite(s): [(CS 542) OR (ECE 545)] (3-0-3)

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)]

(3-0-3)

CS 546

Parallel & Distributed Processing

This course covers general issues of parallel and distributed processing from a user's point of view which includes system architectures, programming, performance evaluation, applications, and the influence of communication and parallelism on algorithm design.

Prerequisite(s): [(CS 430 and CS 450)]

(3-0-3)

CS 547 Wireless Networking

This course introduces cellular/PCS systems, short-range mobile wireless systems fixed wireless systems satellites and

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)] (3-0-3)

CS 548 Broadband No

Broadband Networks

The course studies the architectures, interfaces, protocols, technologies, products and services for broadband (highspeed) 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)]

(3-0-3)

CS 549

Cryptography & Network Security

This course provides an introduction to the theory and practice of cryptography and network security. The course covers conventional encryption such as classical encryption techniques, modern encryption techniques and encryption algorithms. Students are introduced to the basic number theory, which is used as the foundation for public-key encryption. The public-key cryptography such as encryption methods and digital signatures is covered. Message authentication and hash functions are also discussed. Students will learn techniques of key management, secret sharing and conducting interactive proofs. In addition, the practical network and security protocols are discussed. Prerequisite(s): [(CS 430)]

(3-0-3)

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)]

(3-0-3)

CS 551

Operating System Design & 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)] (3-0-3)

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)] (3-0-3)

CS 553

Cloud Computing

This course is a tour through various topics and technologies related to cloud computing. Students will explore solutions and learn design principles for building large network-based systems to support both compute-intensive and data-intensive applications across geographically distributed infrastructure. Topics include resource management, programming models, application models, system characterizations, and implementations. Discussions will often be grounded in the context of deployed cloud computing systems such as Amazon EC2 and S3, Microsoft Azure, Google AppEngine, Eucalyptus, Nimbus, OpenStack, Google's MapReduce, Yahoo's Hadoop, Microsoft's Dryad, Sphere/Sector, and many other systems. The course involves lectures, outside invited speakers, discussions of research papers, programming assignments, and a major project (including both a written report and an

oral presentation). Prerequisite(s): [(CS 450) OR (CS 455)]

(3-0-3)

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)]

(3-0-3)

CS 555

Analytic Models & 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)]

(3-0-3)

CS 556

Cyber-Physical Systems: Languages & 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. (3-0-3)

CS 557

Cyber-Physical Systems: Networking & Algorithms

The goal of the course is to provide students with the necessary foundations to apply wireless sensor networking, scheduling theory, and algorithms in the field of computer science. The focus is to discuss and understand the challenges in emerging cyber-physical systems, open distributed real-time systems, and wireless sensor networks. The course will examine different perspectives of wireless networks such as various MAC protocols, routing protocols, scheduling protocols, localization, clock synchronization, data aggregation and data fusion, compressive and cooperative sensing, security, fault detection and diagnosis, online program, and networked control systems. The course will also examine the interaction of different systems. (3-0-3)

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. (3-0-3)

CS 561

The Computer & 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.

(3-0-3)

CS 565

Computer Assisted Instruction

Hardware and software for the effective use of the computer in an educational environment, CAI (Computer-Assisted/Aided Instruction) being one of the major areas of investigation . Prerequisite(s): [(CS 560) OR (CS 561)] (3-0-3)

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.

 $\begin{array}{l} \mbox{Prerequisite(s): } [(\mbox{CS 560 and CS 561})] \\ (1\mbox{-}4\mbox{-}3) \end{array}$

CS 570

Advanced Computer Architecture

Computer system design and architecture such as pipelining and instruction-level parallelism, memory-hierarchy system, interconnection networks, multicore and multiprocessors, and storage architecture. Selected study on current experimental computer systems.

Prerequisite(s): [(CS 450 and CS 470)] (3-0-3)

CS 572

Advanced Topics in Computer Architecture

Current problems in computer architecture. Prerequisite(s): [(CS 570)] (3-0-3)

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. (3-0-3)

CS 581

Topics in Artificial Intelligence

Covers various advanced topics in AI, including both theory and practice. Content may vary by instructor. Possible topics include: Planning: STRIPs planning; Partial-order planning; Situation calculus; Theorem proving; GraphPlan/SatPlan; Transformational planning; Simulated annealing; Motion planning; Case-based reasoning; Multi-agent coordination; Negotiation planning; Representation and Reasoning: Logical representation; Frame problem; Probabilistic reasoning; Bayesian networks; Game Playing: Minimax search; Evaluation functions; Learning evaluation functions; Markov Decision Processes; Reinforcement learning for games; Developing AI agents; Multi-agent planning. Prerequisite(s): [(CS 480)]

(3-0-3)

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)] (3-0-3)

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.

(3-0-3)

CS 584 Machine Le

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)]

(3-0-3)

CS 585

Natural Language Process

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 445)] (3-0-3)

CS 586

Software Systems Architectures

This course covers the state-of-the-art in architectural design of complex software systems. The course considers commonlyused 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)]

(3-0-3)

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)]

(3-0-3)

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)] (3-0-3)

CS 589

Software Testing & 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)] (3-0-3)

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. (3-0-3)

CS 591

Research & 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 & 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)]

Prerequisite(s): [(Carrow (0-0-3)

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)]

(3-0-3)

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)] (3-0-3)

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)] (3-0-3)

CS 689

Advanced Topics in Software Engineering

Course content is variable and reflects the current trends in software engineering. Instructor permission required. (3-0-3)

CS 691

Research & Thesis Ph.D.

Instructor permission required. (Credit: Variable)

CS 695

Doctoral Seminar Doctoral seminar. (1-0-1)

CS 750

Computer Aid 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)] (2-0-2)

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. Prerequisite(s): [(CS 487)] (2-0-2)

Computer Science Professional Master

CSP 527

Client-Server Applications Development

Through hands-on experience in developing a client-server database project and developing and managing a clientserver 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)]

(3-0-3)

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)](3-0-3)

CSP 542

Internet Design & Analysis Objectives

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)]

(3-0-3)

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)] (3-0-3)

CSP 544

System & Network Security

This course will present an in-depth examination of topics in data and network security such as: Access control, authentication, security assessment, network and data security tools, and security policies. A significant hands-on component includes network incidents to detect and fix. Prerequisite(s): [(CS 430 and CS 455)] (3-0-3)

CSP 545

Wireless Networking Technologies & Applications Objectives

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)]

 $\frac{\text{Prereq}}{(3-0-3)}$

CSP 550

Internet Programming

This course discusses current fundamental concepts and development techniques for distributed applications. Topics covered include multithreaded programs, sockets, messagepassing systems, remote method invocation and procedure calls, peer-to-peer networks, and underlying technologies for internet applications.

Prerequisite(s): [(CS 450)]

(3-0-3)

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)] (3-0-3)

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)]

(3-0-3)

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)] (3-0-3)

CSP 586

Software Modeling Development with UML

Students will obtain a significant exposure to the UML technology. This will include exposure to modeling, modeldriven development, executable models, and round-trip engineering.

 $\begin{array}{l} {\rm Prerequisite(s):} \ [({\rm CS} \ 445) \ {\rm OR} \ ({\rm CS} \ 487)] \\ (3\text{-}0\text{-}3) \end{array}$

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)] (3-0-3)

CSP 595

Topics in Computer Science Professional Master Computer Science topics.

(3-0-3)

Undergraduate Courses Available to Graduate Students

Note: Students may take up to an approved number of the following courses.

CS 411 Computer Graphics

CS 422

Data Mining

CS 425 Database Organization

CS 429 Information Retrieval

CS 430 Introduction to Algorithms

CS 440 Programming Languages and Translators

CS 441

Current Topics in Programming Languages

CS 445 Object Oriented Design and Programming

CS 447 Distributed Objects

CS 450 Operating Systems

CS 455

Data Communications

CS 458 Information Security

CS 470 Computer Architecture

CS 480 Artificial Intelligence Planning and Control

CS 485 Computers and Society

CS 487 Software Engineering I

Institute of Design

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312.595.4906 graduate study information
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design@id.iit.edu
www.id.iit.edu

Dean: Patrick F. Whitney

The Institute of Design (ID) is defined by a legacy of experimentation joined with unique academic programs and a systematic, analytical approach to design and problem solving. It has embraced new technology and experimentation since its founding by Laszlo Moholy-Nagy in 1937 as New Bauhaus. In 1944, the school was renamed the Institute of Design, and, in 1949, it merged with Illinois Institute of Technology.

ID's program is markedly different from other graduate design programs because of its insistence on usercenteredness, its development of rigorous, verifiable methods, and its emphasis on placing design at the center of the development process.

Today, the school has the nation's largest full-time, graduate program in design and offers a Ph.D. in design research. Students in the professional master's (M.Des.) program may specialize in any number of areas, from observing and understanding users in specific contexts, analyzing complex information, developing and exploring alternative solutions, and prototyping future innovations and scenarios. Examples of individual courses of study

Degrees Offered

Master of Design (M.Des.) Master of Design Methods (M.D.M.) include communication design, interaction, product design, strategic planning, user research, design methods research, and systems design. Students in the advanced Master of Design Methods (M.D.M.) program enroll in core and specialty courses and selected workshops focusing exclusively on advanced design methods.

ID's development of separate research and professional degrees addresses the new commitment of the field to the importance of design research, while recognizing the increasing demand for professional education at the mastery level. ID's research community is as unique as its curriculum. Faculty members are active contributors to the design field. The 12 full-time faculty and approximately 40 adjunct members represent specific areas of expertise critical to design, such as product design, communication design, information design, design planning, the history of design, interactive diagrams, cognitive psychology, anthropology, semantics of form, imaging, and computer science. Students draw upon these many perspectives to observe and analyze realworld environments as a means of designing information, visualizations, products, and services that shape and are shaped by how people live.

Graduate students typically come to ID from all over the world, often after years spent in their professions. In addition to professional designers who enter the school, ID accepts and encourages students with backgrounds outside of design. The student body draws from backgrounds as diverse as chemistry, engineering, the fine arts, computer science, architecture, anthropology, and psychology.

Master of Design (M.Des.)/M.B.A. dual degree Doctor of Philosophy (Ph.D.)

Research Facilities

Research is supported by a networked computing system that enables students to digitize and manipulate photographic images, analyze problems, model forms, create interactive multimedia and individualized publications,

Research Areas

ID provides an unmatched community of faculty and students who are conducting essential design research. Interests are broad, but tend to focus on users' interactions with their environment, methods of innovation within organizations, and the value of design for business and develop new systems and tools. Equipment includes Silicon Graphics, Sun, Dell, and Apple computers and a wide variety of peripherals.

and strategy. Doctoral students conduct research regarding the fundamental methods and principles of humancentered design and design planning in both symbolic and real dimensions.

Faculty

Alexis, Jeremy, Senior Lecturer and Assistant Dean. B.Arch., Illinois Institute of Technology; M.Des., IIT Institute of Design.

Erwin, Kim, Assistant Professor. B.A., Loyola University; M.Des., IIT Institute of Design.

Forlano, Laura E., Assistant Professor. B.A., Skidmore College; Diploma, John Hopkins University; Master of International Affairs, M.Phil., Ph.D., Columbia University.

Ichikawa, Tomoko, Visiting Assistant Professor. B.A., International Christian University (Japan); M.S., Illinois Institute of Technology.

Kumar, Vijay, Professor. B.S., National Institute of Design (India); M.S., Illinois Institute of Technology.

MacTavish, Thomas J., Assistant Professor. B.A., Central Michigan University; M.A., University of Iowa; M.A., University of Michigan.

Mathew, Anijo, Assistant Professor. B.Arch., Birla Institute of Technology (India); M.Des. Harvard University.

Admission Requirements

Cumulative undergraduate GPA minimum: 3.0/4.0 Minimum GRE score: 1000 (verbal & quantitative), 3.5 (analytical writing) TOEFL minimum: 550 TSE (Test for Spoken English) minimum: 24

Admission to ID is highly competitive. Meeting the minimum GPA and test score requirements does not guarantee admission. Test scores and GPA are just two of several important factors considered. For admission to the master of design (M.Des.) program, an applicant must hold a baccalaureate degree from an accredited educational institution with a minimum cumulative GPA of 3.0/4.0, must have a strong record of academic achievement, and must be highly recommended. All applicants without an undergraduate degree in design must submit GRE scores. Applicants from countries whose native language is not English must submit scores for TOEFL and TSE. The TOEFL and TSE requirements are waived for applicants with a degree from universities in English speaking countries.

Portfolios are required for applicants who possess design degrees. Regardless of previous degrees, students may be required to complete prerequisite design courses before starting their M.Des. requirements. Applicants without design degrees are encouraged to apply to the M.Des. program. Such applicants must complete a series of specified prerequisite design courses before starting the M.Des. degree requirements. Mayfield, Matthew, Visiting Assistant Professor. B.S., Illinois Institute of Technology; M.C.S., University of Chicago.

Owen, Charles, Distinguished Professor Emeritus. B.S., Purdue University; M.S., Illinois Institute of Technology.

Ruecker, Stan, Associate Professor. B.A., B.Sc., University of Regina; M.Des., Ph.D., University of Alberta (Canada).

Sato, Keiichi, Charles Owen Professor. B.S., M.S., Osaka Institute of Technology (Japan); M.S., IIT Institute of Design.

Thaler, Martin, Visiting Associate Professor. B.F.A., Rhode Island School of Design; M.F.A., Royal College of Art (England).

Whitney, Patrick F., Steelcase/Robert C. Pew Professor of Design and Dean of the IIT Institute of Design. B.F.A., University of Alberta (Canada); M.F.A., Cranbrook Academy of Art.

Applicants to the M.D.M. program must hold a fouryear bachelor's degree from an accredited university, possess outstanding visual skills as demonstrated in a professional portfolio or an exemplary portfolio of nondesign innovation projects, and have a minimum of 10 years of management and leadersip experience in design or innovation and a demonstrated record of excellence in the field (as in awards from IDSA, AIGA, or other associations). Applicants must also submit three letters of recommendation from professional contacts, and have a successful interview with an Institute of Design faculty member.

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. Applicants with design degrees or degrees from programs in related fields with studio courses must present a portfolio and may be required to complete some design courses as deficiency studies. All Ph.D. applicants must have completed college level courses in mathematics (calculus and statistics) and programming (Fortran, Pascal, or C++). Depending on the applicant's academic background and intended area of study, other prerequisite courses may also be required. Admitted applicants who have not completed these courses must take them immediately.

Master of Design

54 credit hours

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 of communication or product design, or design planning. The degree terminates with a project demonstrating the application of new theories and processes to contemporary and developing design problems in a variety of areas.

The program does not require the formal selection of a concentration area or track. Students may construct their own curriculum after taking a core of methods courses focused on observing and understanding users

Curriculum

54 credit hours

Required Courses

6.5 credit hours

- ID 514 Design Planning
- ID 516 Observing Users
- ID 533 Design Analysis
- ID 559 Physical Human Factors

Elective Courses

47.5 credit hours

Students select a series of courses from the available workshops and seminars to meet the objectives of the student's professional goals. Choices will be made in consultation with the student's advisor and will count for at least 41 hours of the required program.

- ID 428 Adv. Architectural Photo
- ID 481 Graduate Intro to Design 1
- ID 482 Graduate Intro to Design 2
- ID 483 Graduate Intro to Comm Design 1
- ID 484 Graduate Intro to Comm Design 2
- ID 485 Graduate Intro to Product Design 1
- ID 486 Graduate Intro to Product Design 2
- ID 487 Graduate Intro To Photography
- ID 488 Graduate Intro To Digital Media
- ID 510 $\,$ Principles and Methods of Research
- ID 511 Philosophical Context of Design Research
- ID 515 Design Policy
- ID 517 Design Languages
- ID 518 Business Frameworks
- ID 519 Economics and Design
- ID 520 Communication Planning
- ID 521 Product Planning
- ID 522 Technological Development and Design Innovation
- ID 524 Strategic Design Planning
- ID 525 Design Planning and Technological Innovation
- ID 526 Design Planning and Market Forces
- ID 528 Advanced Design Planning
- ID 529 Structured Planning
- ID 530 Information Structuring

in specific contexts, analyxing complex information, developing and exploring alternative solutions, and prototyping future innovations and scenarios. Examples of individual courses of study include communication design, interaction, 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 course work each semester.

- ID 531 Computer Apps in Design
- ID 534 Design Synthesis
- ID 535 Decision Making
- ID 536 Concept Evaluation
- ID 538 Service Design
- ID 540 Advanced Communication Design
- ID 541 Advanced Product Development
- ID 542 Interaction for Products
- ID 543 New Product Definition
- ID 544 Interface Design
- ID 545 Interactive Media
- ID 546 Diagram Development
- ID 547 Product Architecture and Platform
- ID 548 Life Cycle Design
- ID 554 Visual Language
- ID 555 Metaphor and Analogy in Design
- ID 556 Meaning and Form
- ID 557 Dynamic Diagrams
- ID 558 Theories of Information and Communication
- ID 559 Physical Human Factors
- ID 567 Economics of Product Development
- ID 568 Research Methods for Product Development
- ID 569 Intellectual Property and Product Development
- ID 572 Systems and Systems Theory in Design
- ID 573 Design Planning: Opportunity Identification
- ID 574 Design Planning: Developing Options
- ID 577 Product Form
- ID 578 Design Planning Implementation
- ID 579 Production Methods
- ID 580 Design Workshop
- ID 581 Photo Workshop
- ID 582 Comm Design Workshop
- ID 583 Prod Design Workshop
- ID 584 Design Planning Workshop
- ID 588 Interactive Media Workshop
- ID 589 Systems Workshop
- ID 592 Research and Demo
- ID 598 Special Topics
- ID 685 Dissertation Seminar
- ID 691 Research and Thesis for Ph.D.

Master of Design Methods

 $30 \ {\rm credit \ hours}$

The Master of Design Methods (MDM) is a nine month (or 2 year part-time) executive master's degree for exceptional design, management, engineering, and other professionals who wish to acquire robust design methods and frameworks and to apply design thinking to the development of products, communications, services, and systems. MDM courses cover design methods and frameworks in areas like user observation and research;

Curriculum

30 hours

Required Courses

6.5 hours

- ID 514Design PlanningID 516Observing UsersID 533Design Analysis
- ID 559 Physical Human Factors

Dual Degree Program

M.Des./M.B.A.

44 Institute of Design Credits36 Stuart School of Business Credits

Required Courses

6.5 Credit Hours from Institute of Design

- ID 514 Design Planning
- ID 516 Observing Users
- ID 533 Design Analysis
- ID 559 Physical Human Factors

30 Credit Hours from Stuart School of Business

- MBA 501 Accounting for Strategic Decision Making
- MBA 505 Contemporary Economic Analysis & Game Theory
- MBA 509 Financial Management in a Globalized World
- MBA 511 Creating, Communicating, & Delivering Customer Value
- MBA 513 Operations & Technology Management

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, four semesters half time, or six semesters at one-third time.

Elective Courses

23.5 hours

Students select a series of courses from the available workshops and seminars to meet the objectives of the student's professional goals. Choices will be made in consultation with the student's advisor and will count for at least 23.5 hours of the required program.

Students select from the same pool of elective classes as found under the Master of Design description.

Elective Courses

37.5 hours - Institute of Design6 hours - Stuart School of Business

The program director or academic advisor will develop a curriculum plan when the student begins the dualdegree program. Typically, students will save because M.B.A. will double count 6 M.Des. credits towards general electives and 6 credits towards the Design Leadership concentration, and M.Des. will double count 6 M.B.A. credits towards electives. The program director may make exceptions to this plan depending upon the student's individual situation.

Doctor of Philosophy

107 credit hours Language examination Comprehensive examination Dissertation

The Ph.D. in design is a research program for those who wish to teach or conduct research in design. The program culminates with a dissertation that extends the body of knowledge about design theory and process. With the approval of their advisors, students may elect to study within the design planning or human-centered design tracks, or they may develop a different area of study that is important to the evolution of new knowledge in design theory or process.

Candidacy

Early in their studies, admitted doctoral students will be required to submit and obtain approval for a program of study and pass a foreign language requirement. Within two years of being admitted, and after approval of the program of study and passage of the foreign language

Curriculum

107 credit hours total

Master's Program in Design 32 hours or greater

Research Sequence

21 hours

The research sequence is a series of projects and courses selected from available design workshops and specialty courses to meet the objectives of the student's research goals. Choices will be made in consultation with the student's advisor and will account for at least 21 credit hours of the required program beyond the M.S. degree.

Design Workshops

Workshops are major, semester-long project courses that explore design problems in breadth and depth. Processes and information from the specialty courses are developed here in practical and experimental applications. Choices are made in consultation with the student's advisor from ID classes numbered 580-589. examination, the student must take a comprehensive examination. This examination is intended as a rigorous review of the level of competence achieved by the student as a result of the entire program of graduate study (except for the dissertation) as approved by the advisory committee and specified in the program of study form. Students are not considered candidates for the Ph.D. degree until after the comprehensive examination is passed.

Residence

The Ph.D. program normally requires a minimum of three years of study beyond the master's degree. The first four semesters must be continuous study at the Institute of Design. Students must enroll in at least 15 credit hours of course work for each of the first three semesters.

Language Satisfactory reading knowledge of German, Japanese, French, or Russian must be met before the student applies to take the comprehensive examination.

Specialty Courses

Specialty courses are courses in special branches of design theory, process or practice, and are normally selected from half-semester courses, ID 500–559 and ID 568–576.

Seminars

6 hours

Seminars are discussion courses that consider topics of contemporary interest and provide a continuing meeting ground and forum for students during their course and project work.

Electives

12 hours

Electives include full- or half- semester courses selected from the university's course offerings to complement objectives of the student's program. These courses should be at least 400-level and should be selected with advisor approval. Note: Summer research on projects designated by the department may substitute for up to three hours of elective or research sequence credit requirements.

Dissertation

48 hours

A distinct, substantial, and original contribution to design knowledge. ID 691 Research and Thesis for the Ph.D.

Course Descriptions

Numbers in parentheses indicate class, lab and credit hours, respectively. Graduate standing in the Institute of Design is a prerequisite for all courses.

ID 510

Principles & 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. (3-0-1.5)

ID 511

Philosophical Context of Dsgn

Explores the philosophical framework for conducting research and building knowledge in the field of design. Topics include concepts from epistemology, phenomology and structuralism. Comparisons are made between design research and research in other fields.

(3-0-1.5)

ID 514

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 . Particular attention is paid to how, within the context of all of these forces, design can benefit an organization.

(3-0-1.5)

ID 515

Design Policy

Investigates the formation and intent of design policy by governments across the world. Particular attention is focused on the relationship of organizations implementing these policies to the political and economic structure of different countries and on measures assessing their success. (3-0-1.5)

(5-0-1.5)

ID 516

Observing Users

Introduces observational and ethnographic methods in design. Ethnographic methods are used in field work to help researchers develop a deeper understanding of the everyday activities of people's lives. In other words their goal is to help researchers understand what people do – not just what they say they do. In the design field, there is an added goal to initiate practical changes in the ways people do thins in the real material world – not just to make theoretical discoveries. Applied methods help designers conduct research projects and develop design solutions for customers, clients, or employers who seek out their expertise.

(1-2-2)

ID 517

Design Languages

Graduate standing in the Institute of Design. 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.

(1-2-2)

ID 518

Business Frameworks

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. (3-0-1.5)

ID 519

Economics & Design

This course will consider the relationship between theories and practice in the two very different realms of economics and design. Economic theory is a vital body of knowledge with many variations and emphases. It has fundamentally influenced a wide spectrum of both governmental and business policy and procedure and has enormous influence on how design is viewed in these context. (3-0-1.5)

ID 520

Communication Planning

Presents and demonstrates the principles and methods of formulating a plan for a communication project, especially the relationship between the project plan and the organization's overall design strategy and policy. (3-0-1.5)

ID 521

Product Planning

Presents and demonstrates the principles and methods of formulating a plan for a new product, especially the relationship between the project plan and the organization's overall design strategy and policy. (3-0-1.5)

ID 522

Technological Development & Design Innovation

Concentrates on the exploitation of developments in material and manufacturing technology as a critical component in innovative design. Case studies are used to analyze the development of new products from precursor advancements in the technologies of materials and/or manufacturing. Product development is considered from perspective of project management, interactions among different technological domains, and the metaphoric transformation of design problems by design and development personnel aware of the technological advancements. (3-0-1.5)

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ID 524 Strategic Design Planning

Focuses on how the processes and goals of design planning can relate to the overall strategic plan of an organization. It includes topics related to technological innovation, market trends, financial analysis, and other forces that influence the future of an organization. (3-0-1.5)

ID 525

Design Planning & Technological Innovation

Shows how design relates to technological change in media, manufacturing and products. Special attention is paid to the confluence of computing and communication, flexible production systems and the increased use of sophisticated electronics in control systems of products. (3-0-1.5)

Design Planning & Market Forces

Focuses on methods in design planning that build information about how products and information should be used. It includes a comparison of marketing and design planning as distinct processes for developing new products, services and information.

(3-0-1.5)

ID 528

Advanced Design Planning

Presents students with background information about the forces influencing a design problem. Using knowledge about planning processes, students will be asked to write a design plan that describes the relevant methods and predicted solution to the problem. (3-0-1.5)

ID 529

Structured Planning

Introduces concepts for establishing relationships among elements of tools used in the planning phase of the design process. Procedures are developed for exploring the issues relevant to a project, obtaining detailed functional requirements and insights, organizing this information, synthesizing innovative concepts and describing them in a Plan for the subsequent designing phase. (3-0-1.5)

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ID 530

Info Structuring

Introduces the basic principles and methods of Structured Planning, a set of information and creating information structures from them. Theoretical models for measuring similarity and interaction are developed and used to create graphs representing information networks. Computer techniques are presented for decomposing these structures into clusters and hierarchically recomposing them as information structures. (3-0-1.5)

ID 531

Computer Applications in Design

Introduces students to the construction of computer programs for design. Issues of program design are considered, including modularity, data structures, computer graphic modeling, interface design and other aspects of programming for the support of design processes.

Prerequisite(s): [(ID 468)]

(3-0-1.5)

ID 532

Computer-Supported Design Processes

Continuation of ID 531, with emphasis on advanced graphic techniques and artificial intelligence procedures for the support of design processes. Primary emphasis is on writing a complete design software application program.

Prerequisite(s): $[(ID 531^*)]$ An asterisk (*) designates a course which may be taken concurrently.

(3-0-1.5)

ID 533

Design Analysis

A survey of design methods from many fields concentrating on problem definition, description and analysis. Among the topics covered are diagrammatic techniques for process and organizational description, semantic differential techniques, means/ends analysis and morphological analysis. (3-0-1.5)

ID 534 Design Synthesis

A survey of design methods for enhancing creativity and developing concepts. Topics include morphological synthesis, a wide variety of creativity stimulation techniques, synectics and other group creativity processes.

(3-0-1.5)

ID 535

Decision Making in Design

This course covers methods for making decisions at various stages of a design or planning project. It provides a broad coverage on how people make decisions under varying conditions of uncertainty and complexity. There will be discussions on making design decisions based on data and alternatives available for a project. This course will also teach how to manage and lead the decision-making process in organizations. (3-0-1.5)

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ID 536 Concept Evaluation

The synthesis phase of a design project produces a number of concepts with varying degrees of significance to the project needs. This course will provide frameworks and tools to evaluate such concepts and to identify the ones that are most valuable to the business and users. The course will start by creating a strategic approach to concept evaluation and then detail how to evaluate individual concepts. Half semester course

(3-0-1.5)

ID 537 Problem Eramin

Problem Framing

This class presents a practical framework and tools to help designers accurately frame design problems; a proper problem frame will address root causes, not just symptoms of the problem. The class will also provide tools and methods that ensure appropriate scoping of and resource for the problem. (3-0-1.5)

ID 538

Service Design

Design principles and skills that are needed for the design of services. Topics include the nature of services, customer acquisition and retention, value propositions in service business, service prototyping & pilot testing, stakeholder management, infrastructure, operational and implementation issues. The course will also introduce design methods and teach how to apply them in the field. Half semester course (3-0-1.5)

ID 540

Advanced Communication Design

Involves students in practicing methods for rapidly developing prototypes that demonstrate appearance and/or functional aspects of potential messages. The class will include evaluation methods that are useful in the process of iteratively developing and testing alternate solutions. (2-2-1.5)

ID 541

Advanced Product Development

Familiarizes students with the nature, methods, and design implications of current mass production practice and trends. Addresses the translation of product concepts into actual production by anticipating development needs in all portions of the manufacturing organization. (2-2-1.5)

IIT Graduate Bulletin 2012-2014

Interaction Design Methods

This course focuses on a role of design to bring technologies to human contexts by creating interaction mechanisms for better user experiences. The content includes the concept of interaction, underlying theories, as well as methods for understanding user needs and contexts, representing different aspects of interaction, and designing and evaluating interactive systems.

(3-0-1.5)

ID 543

New Product Definition

In most organizations, a description of the product or service that needs to be developed is completed before design and engineering become involved. The process of completing a description of what needs to be designed and developed is called 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. (3-0-1.5)

(3-0-1.5)

ID 544

Interface Design

Focuses on user-computer interface design. Topics included are cognitive models, interactive techniques, sign systems, display organization and prototyping methods. Working knowledge of computer programming

(3-0-1.5)

ID 545

Interactive Media

Introduces students to the principles of integrating electronic publishing, interactive video and computer graphics. Particular emphasis is on social and cognitive human factors and the use of multiple sign systems. (3-0-1.5)

(3-0-1.3

ID 546

Diagram Development

Explores the language of diagrams and alternative techniques for increasing communication effectiveness. Subjects of study include computer-based diagrams that introduce interaction and motion to convey meaning. (3-0-1.5)

ID 547

Product Architecture & Platform

Product architecture is the structure that integrates components and subsystems of a product into a coherent mechanism to perform intended behavior and functions. It also reflects rationale and intentions of the design from different perspectives. In order to accommodate a wide range of user requirements and social concerns as well as fast changing technologies, strategic approaches and methodologies for designing product architecture and platform need to be incorporated in the design process. This course introduces the concept of product architecture and platform to explore their possible applications to different types of products from different viewpoints. (2, 0, 15)

(3-0-1.5)

ID 548

Life Cycle & Sustainable Design

Life Cycle & Sustainable Design introduces students to the issues, resources, and methods of designing product systems with consideration for their environmental and social impact throughout their lifecycle. The course is formatted to help students develop a professional point of view and set of references for assessing lifecycle and sustainable issues when developing new products. Meets for one-half of the semester. (3-0-1.5)

ID 549

Prototyping Methods

The ability or make preliminary things and experiment with them before a final product is developed greatly enhances the product development process. This course introduces and explores a wide variety of prototypes and how they can be used to inform new product development. How prototyping affects understanding of the project goals, management of the process, project risk, learning, and quality are explored. Paper prototypes, architecture & platform prototypes, behavioral prototypes, interactive prototypes, visualizations, simulations are examples of the types of prototypes that are examined. Meets for one-half of the semester. (3-0-1.5)

ID 551

Cognitive Human Factors

Presents the advanced ideas and methods that can be used to design information and products that fit the cognitive abilities of people. Important topics include designing information that corresponds to mental models of users, control systems that help users develop appropriate mental models and the analysis of different methods of representing information. (3-0-1.5)

ID 552

Social Human Factors

Presents advanced ideas and methods used to design information, products and environments that fit the social patterns of groups. Particular attention is paid to understanding and designing systems that support group work.

(3-0-1.5)

ID 553

Cultural Human Factors

Presents ideas and principles used to understand the relationship between design and cultural values and behavior. Emphasis is placed on designing information and products for people who are from significantly different cultures. (3-0-1.5)

ID 554

Visual Language

Discusses pictures, abstract symbols, text, numbers, diagrams, three-dimensional form and other sign systems. Particular attention is paid to the relative advantages of each representation system for conveying different types of information. (3-0-1.5)

ID 555

Metaphor & Analogy in Design

Investigates the ideas and methods for creating visual messages through comparing, juxtaposing and substituting images within specific contexts. Discussion will include issues of similarity, such as isomorphism and analogy, the connotative attributes of images, and the dissonance found in metaphors and other rhetorical forms. (3-0-1.5)

Dynamic Diagrams

The study and development of real-time, computer-based diagrams for pattern finding and pattern communicating. Particular attention is paid to the roles of motion, interaction, sound, and modes of manipulation that can be combined with 3-D models and traditional diagrammatic sign systems. (3-0-1.5)

ID 558

Theories of Information & Communication

Describes general paradigms of information and communication. Particular attention is paid to models that consider the importance of the values, behavior and knowledge of the people for whom the information is intended. (3-0-1.5)

ID 559

Physical Human Factors

The physical aspect of human experience and interaction design is investigated through topics such as learning by doing: interaction between actions and cognition, physical enhancement of cognitive activities, spatiointerface: temporal dimensions of interaction design, and the shared reality concept for multi-modal communication.

(3-0-1.5)

ID 567

Economics of Product Development

Successful new products drive the growth and profitability of organizations. But the development of these new products relies on considered investments, quality development processes, and an expected return on the investment. This course introduces the numerous economic considerations and measures with which the successful new product developer must be familiar. Project budgeting, return on investment, net present value, cash flow analysis, product pricing, and budgeting are among the concepts explored from a design and development viewpoint. (3-0-1.5)

ID 568

Research Methods for New Product Development

The design and development of new products requires rigorous research throughout the process to improve insight and reduce the risk of innovation. Ethnographic and activity-based methods are used early to identify latent needs. Behavioral testing with prototypes is used to understand the quality of emerging concepts. Quantitative and qualitative validation studies help understand final concepts in detailed ways. This course examines research methods used throughout the design and development process from process, financial, and results standpoints. (3-0-1.5)

ID 569

Intellectual Property

The opportunity to protect one's unique and valuable ideas is a core tenet of the global economic system and is embodied in the laws of intellectual property. Disciplines such as design and engineering that are involved in the development of new ideas must actively pursue this protection. This course introduces the principles and methods for securing intellectual property rights. Topics covered include utility and design patents, trademark, copyright, and trade dress. Emphasis is placed on the ability to articulate novelty, the appropriate process of securing intellectual property, and common ways intellectual property can be valued.

(3-0-1.5)

ID 570

Case Studies in Advanced Design

Involves students in reading and discussing the role of design in the context of case studies. Particular attention will be paid to the relationship between design and other forces influencing the goals of the organization. Case studies may relate to either design planning of human-centered design. (3-0-1.5)

ID 571

Case Study Development

Focuses on the methods of researching and writing a case study of a significant project in either design planning or human-centered design. (3-0-1.5)

ID 572

Systems & Systems Theory in Design

Investigates principles and methods for exploring the behavior of systems. System dynamics techniques are used to model design concepts with the goal of revealing complex, noninceptive relationships. Important topics include general systems theory, modeling, causality and formalisms. (3-0-1.5)

ID 573

Phase 0: Opportunity Identification

Methods and approaches for phase 0 projects in design practice. These cover ways to help businesses define new opportunity spaces for new products, services, and business models.

(3-0-1.5)

ID 574

Phase 1: Developing Options

Methods and approaches for developing real options based on a point of view developed during a phase 0 project. (3-0-1.5)

ID 577

Product Form

The form of a product is a result of resolving technical conditions, organizing the product for use, and a means for communicating. In this course students examine what technical and social dimensions impact product form and conversely, how product form can be controlled by the designer to improve the product's form and corporate identity; visual trends, new materials, semantics, product architecture, ergonomics, specific industries and others. (3-0-1.5)

ID 578

Design Planning Implementation

Introduces frameworks and methods for effectively implementing change in organizations. Using cases, students will identify principles, actions and measures that mitigate risk, improve implementation success, and inform stronger designs. (3-0-1.5)

ID 579

Production Methods

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.

(3-0-1.5)

ID 580 Design Workshop

Involves students from across the programs in projects that demonstrate how new theories and processes can be applied to complex design projects. (Credit: Variable) (Credit: Variable)

Photography Workshop

Involves students in a major project that is in the context of contemporary ideas in photography. (Credit: Variable) (Credit: Variable)

ID 582

Communication Design Workshop

A project oriented workshop focusing on design principles that link theoretical methods to practice in the area of human-centered communication design. (Credit: Variable) (Credit: Variable)

ID 583

Product Design Worshop

A project-oriented workshop focusing on design principles that link theoretical methods to practice in the area of human-centered product design. (Credit: Variable). Graduate standing in design. (Credit: Variable)

ID 584

Design Planning Workshop

A project-oriented workshop that involves students in analyzing user needs, conceiving of innovations, and developing plans for new communications, products and businesses. Students will present their ideas through plans, prototypes and demonstrations. (Credit: Variable). (Credit: Variable)

ID 588

Interactive Media Workshop

A graduate level, project oriented survey of the methods and issues in the creation of interactive multi-media software. Methods will cover the use of several authoring systems and the effective use and combination of the five basic data types: text, graphics, sound, animation and video. Issues addressed will be metaphor, mapping, informational organization, interactive strategies, navigation, tailoring, and alternative communication models for user-controlled environments. (2-6-4)

ID 589

System Design Workshop

Introduces the application of structured planning methods to complex design problems at the system level. Team techniques are emphasized, and formatted information handling and computer-supported structuring processes are used at appropriate stages of project definition, information development, structuring, concept development and communication. (Credit: Variable) (Credit: Variable)

ID 591

Research & Thesis M.S. Research and thesis writing

(Credit: Variable)

ID 592

Research & Demonstration Project for Master of Design $\operatorname{Research}$ and demonstration

(Credit: Variable)

ID 595

Internship

Supervision of participation in Curricular Practical Training. Internship, supervisor requirement, non-credit. (0-0-0)

ID 598

Special Problems Special problems (Credit: Variable)

ID 685

Ph. D. Research Seminar

Good standing in the ID Ph.D. program. 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. (3-0-3)

ID 691

Research & Thesis PHD Research and thesis writing (Credit: Variable)

Department of Electrical and Computer Engineering

103 Siegel Hall 3301 S. Dearborn St. Chicago, IL 60616 312.567.3400 312.567.7995 fax gradinfo@ece.iit.edu www.ece.iit.edu

Interim Chair: Geoffrey Williamson

Associate Chair: Jafar Saniie

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 course work, the department offers a number of professional master's degrees and certificate programs to enable practicing engineers to pursue continuing education in their areas of interest. Faculty members are engaged in research in the forefront of their fields, with funding derived from industrial and government research grants and contracts, which provide support to graduate students in the form of research assistantships, in addition to the development and the maintenance of the research facilities. The department also offers a number of fellowships and teaching assistantships on a competitive basis.

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

For many years, the graduate programs offered by the department have facilitated professionals in industry to advance their knowledge through the pursuit of graduate degrees. IIT Online, the interactive distance learning facility of IIT, 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.

Degrees Offered

Master of Science in Electrical Engineering Master of Science in Computer Engineering Master of Science in Computer Engineering and Electrical Engineering (dual degree) Master of Biomedical Imaging and Signals Master of Electrical and Computer Engineering

Joint Degree Programs

With the Department of Computer Science: Master of Telecommunications and Software Engineering

Certificate Programs

Advanced Electronics Applied Electromagnetics Communication Systems Computer Engineering Control Systems Master of Network Engineering Master of Power Engineering Master of VLSI and Microelectronics Doctor of Philosophy in Electrical Engineering Doctor of Philosophy in Computer Engineering

With the Center for Financial Markets: Master of Electricity Markets

Electricity Markets Power Electronics Power Engineering Signal Processing Wireless Communications Engineering

Interdisciplinary Programs

Master of Science in Electrical Engineering with specialization in energy/environment/economics (E^3)

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.

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 highspeed Ethernet, (wired and wireless), which in turn is connected to the university's backbone and the Internet.

The department has state-of-the-art computer systems

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; signal and image processing.

Faculty

Anjali, Tricha, Associate Professor. B.S., M.S., Indian Institute of Technology; Ph.D., Georgia Institute of Technology. Wireless networks, network security, network routing, multipath routing, network optimization, remote education.

Arzbacher, Robert, Emeritus Professor. Ph.D., University of Illinois, Urbana-Champaign. Instrumentation, signal processing and control.

Atkin, Guillermo E., Associate Professor. B.S., Universidad F. Santa Maria (Chile); Ph.D., University of Waterloo (Canada). Modulation and coding, digital mobile and wireless communication, spread spectrum and optical communication systems.

Borkar, Suresh, Senior Lecturer. B. Tech Indian Institute of Technology (India); M.S., Ph.D., Illinois Institute of Technology. Wireless and wireline telecommunications, operating systems, architecture, and performance of computer and network systems.

Brankov, Jovan G., Assistant Professor. Diploma, University of Belgrade (Serbia); M.S., Ph.D., Illinois Institute of Technology. Medical imaging, image sequence processing, pattern recognition and data mining.

Brown, Ian, Assistant Professor. B.S., Swarthmore College; M.S., Ph.D., University of Wisconsin-Madison. Design and modeling of electric machines, adjustable speed drives, and power electronics applied to renewable energy systems and energy efficient power conversion.

Cheng, Yu, Associate Professor. B.E., M.E., Tsinghua University (China); Ph.D. University of Waterloo (Canada). Wireless networks, network security, network measurement, and wireless/wireline interworking.

Choi, Kyuwon, Assistant Professor. B.S., M.S., KyungHee University (Korea); Ph.D., Georgia Institute of Technology. VLSI design and automation for low power.

Flueck, Alexander J., Associate Professor. B.S., M.E., Ph.D., Cornell University. Power systems, high performance computing, autonomous agent-based control.

Kim, Joohee, Assistant Professor. B.S., M.S., Yonsei University (Korea); Ph.D., Georgia Institute of Technology. Multimedia signal processing, multimedia communications and networking, computer vision..

Kirshnamurthy, Mahesh, Assistant Professor. B.E., Amrawati University (India); M.S., University of Missouri- Rolla; Ph.D., University of Texas-Arlington. Power electronics, electric machines, adjustable speed drives and energy storage, systems for renewable energy, and automotive applications. Li, Zuyi, Associate Professor and Associate Director of the Smart Grid Center. B.S., Shanghai Jiaotong University; M.S., Tsinghua University; Ph.D., Illinois Institute of Technology. Market operation of electric power system and integration of renewable energy, smart grid, power system protection.

Modir Shanechi, Hassan, Senior Lecturer. B.S., M.S., Tehran University (Iran); Ph.D., Michigan State University. Nonlinear and intelligent systems, power system dynamics and security.

Oruklu, Erdal, Assistant Professor. B.S., Technical University of Istanbul (Turkey); M.S., Bogazici University (Turkey); Ph.D., Illinois Institute of Technology. VLSI and SoC design, signal processing architectures, digital arithmetic, computer systems.

Saletta, Gerald F., Emeritus Professor. B.S., M.S., University of Notre Dame; Ph.D., Illinois Institute of Technology. Electronics, digital systems.

Saniie, Jafar, Filmer Professor and Associate Chair. B.S., University of Maryland; M.S., Case Western Reserve University; Ph.D., Purdue University. Embedded computing, DSP architectures, signal and image processing, detection and estimation, ultrasonic imaging for both medical and industrial applications.

Shahidehpour, Mohammad, Bodine Professor of Electrical and Computer Engineering, Director of the Smart Grid Center, and Associate Director of the Wanger Institute for Sustainable Energy Research (WISER), . B.S., Arya-Mehr University of Technology (Iran); M.S., Ph.D., University of Missouri-Columbia. Large-scale power systems, nonlinear stochastic systems, optimization theory.

Shen, Zheng John, Grainger Professor of Electrical and Computer Engineering. B.S., Tsinghua University (China); M.S., Ph.D., Rensselaer Polytechnic Institute.

Stark, Henry, Emeritus Professor. B.E.E., City College of New York; M.S., D.Eng.Sc., Columbia University. Image reconstruction, medical imaging, pattern recognition, signal processing and sampling theory, optics.

Wang, Jia, Assistant Professor. B.S., Tsinghua University (China); M.S., Ph.D., Northwestern University. VLSI, design automation, and algorithm design.

Weber, Erwin W., Emeritus Professor. B.S., M.S., Ph.D., Illinois Institute of Technology. Electromagnetics, RF electronics, antenna theory.

Wernick, Miles, Motorola Professor of Electrical and Computer Engineering and Director of Medical Imaging in the Pritzker Institute of Biomedical Science and Engineering. B.A., Northwestern University; Ph.D., University of Rochester. Medical imaging, image processing, and pattern recognition. Williamson, Geoffrey A., Professor and Interim Chair. B.S., M.S., Ph.D., Cornell University. Parameter estimation and system identification, adaptive signal processing and control, control systems.

Wong, Thomas Tang Yum, Professor. B.S., University of Hong Kong; M.S., Ph.D., Northwestern University. Applied electromagnetics, microwave and terahertz measurements, nanoscale structures and devices.

Xu, Yang, Assistant Professor. B.S., M.S., Fudan University (China); Ph.D., Carnegie Mellon University. RFIC design for digital communications and wireless medical technology. Yang, Yongyi, Harris Perlstein Professor of Electrical and Computer Engineering. B.S.E.E., M.S.E.E., Northern Jiatong University (China); M.S., Ph.D., Illinois Institute of Technology. Image and signal processing, data compression, applied mathematical and statistical methods.

Yetik, Imam Samil, Assistant Professor. B.S., Bogazici University (Turkey), M.S., Bilkent University (Turkey), Ph.D., University of Illinois at Chicago. Statistical signal and image processing with applications to biomedicine.

Zhou, Chi, Associate Professor. B.S., Tsinghua University (China), M.S., Ph.D., Northwestern University. Wireless sensor networks for smart grid application, scheduling for OFDM/MIMO systems, network coding for wireless mesh networks, integration of optical and wireless networks.

Admission Requirements

Cumulative undergraduate GPA minimum: 3.0/4.0

- 1. GRE score: M.S./MAS: 1100 (quantitative + verbal) 3.5 (analytical writing)
- 2. New GRE score: M.S./MAS: 304 (quantitative + verbal) 3.5 (analytical writing)
- 1. GRE score: Ph.D.: 1100 (quantitative + verbal) 3.5 (analytical writing)
- New GRE score: Ph.D.: 304 (quantitative + verbal)
 3.5 (analytical writing)

TOEFL minimum score: 550/213/80*

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 IIT. 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 advisor 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.

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

Master of Science in Electrical Engineering

32 credit hours Thesis option

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 advisor. 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 fulltime 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 IIT's ECE 211 and ECE 213 (Circuit Analysis I and II), ECE 218 (Digital Systems), ECE 307 (Electrodynamics), ECE 308 (Signals and Systems), ECE 311 (Engineering Elec-

tronics), MATH 251 (Multivariate and Vector Calculus), and MATH 252 (Introduction to Differential Equations). 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 credits of ECE short courses may be applied to the degree.

Students, with advisor 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 listed on the next page and a minimum of two courses from the other areas. An M.S.E.E. candidate may, with permission of a thesis advisor, include in his or her 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.

EE Areas of Concentration

I. Communications and Signal Processing

- ECE 401 Communication Electronics
- ECE 403 Digital and Data Communication Systems ECE 405 Digital and Data Communication Systems with Laboratory
- ECE 421 Microwave Circuits and Systems
- ECE 423 Microwave Circuits and Systems with Laboratory
- ECE 436 Digital Signal Processing I with Laboratory
- ECE 437 Digital Signal Processing I
- ECE 481 Image Processing
- ECE 504 Wireless Communication System Design
- $\rm ECE~507~$ Imaging Theory and Applications
- ECE 508 Video Communications
- ECE 509 Electromagnetic Field Theory
- ECE 511 Analysis of Random Signals
- ECE 513 Communication Engineering Fundamentals
- ECE 514 Digital Communication Principles
- ECE 515 Modern Digital Communications
- ECE 519 Coding for Reliable Communications
- ECE 522 Electromagnetic Compatibility
- ECE 565 Computer Vision and Image Processing
- ECE 566 Statistical Pattern Recognition
- ECE 567 Statistical Signal Processing
- ECE 568 Digital Speech Processing
- ECE 569 Digital Signal Processing II
- ECE 570 Fiber Optic Communication Systems
- ECE 576 Antenna Theory
- ECE 578 Microwave Theory

II. Computers and Microelectronics

- ECE 407 Introduction to Computer Networks with Laboratory
 ECE 408 Introduction to Computer Networks
 ECE 415 Solid-State Electronics
 ECE 425 Analysis and Design of Integrated Circuits
 ECE 429 Introduction to VLSI Design
 ECE 441 Microcomputers
- ECE 443 Introduction to Computer Security
- ECE 446 Advanced Logic Design
- ECE 449 Object-Oriented Programming and Computer Simulation
- ECE 485 Computer Organization and Design
- ECE 502 Basic Network Theory
- ECE 521 Quantum Electronics
- $\rm ECE~524~$ Advanced Electronic Circuit Design
- ECE 525 RF Integrated Circuit Design
- ECE 526 Active Filter Design
- ECE 527 Performance Analysis of RF Integrated Circuits
- ECE 529 Advanced VLSI Systems Design
- ECE 530 High Performance VLSI/IC Systems
- ECE 541 Performance Evaluations of Computer Networks

- ECE 542 Design and Optimization of Computer Networks
- ECE 543 Computer Network Security
- ECE 544 $\,$ Wireless and Mobile Networks $\,$
- ECE 545 Advanced Computer Networks
- ECE 546 Wireless Network Security
- ECE 547 Wireless Network Performance Analysis
- ECE 571 Nanodevices and Technology
- ECE 575 Electron Devices
- ECE 583 High Speed Computer Arithmetic
- ECE 584 VLSI Architectures for Signal Processing and Communications
- ECE 585 Advanced Computer Architecture
- ECE 586 Fault Detection in Digital Circuits
- ECE 587 Hardware/Software Codesign
- ECE 588 CAD Techniques for VLSI Design
- ECE 589 Computer-Aided Design of Analog IC

III. Power and Control

- ECE 411 Power Electronics
- ECE 412 Electric Motor Drives
- ECE 417 Power Distribution Engineering
- ECE 418 Power Systems Analysis
- ECE 419 Power Systems Analysis with Laboratory
- ECE 420 Analytical Methods in Power Systems
- ECE 438 Control Systems
- ECE 505 Applied Optimization for Engineers
- ECE 506 Analysis of Nonlinear Systems
- ECE 531 Linear System Theory
- ECE 535 Discrete Time Systems
- ECE 538 Renewable Energies
- ECE 539 Computer Aided Design of Electric Machines
- ECE 540 Reliability Theory and System Implementation
- ECE 548 Energy Harvesting
- ECE 549 Motion Control Systems Dynamics
- ECE 550 Power Electronic Dynamics and Control
- ECE 551 Advanced Power Electronics
- ECE 552 Adjustable Speed Drives
- ECE 553 Power System Planning
- ECE 554 Power Systems Relaying
- ECE 555 Power Market Operations
- ECE 556 Power Market Economics and Security
- ECE 557 Fault-Tolerant Power Systems
- ECE 558 Power System Reliability
- ECE 559 High-Voltage Power Transmission
- ECE 560 Power Systems Dynamics and Stability
- ECE 561 Deregulated Power Systems
- ECE 562 Power System Transaction Management
- ECE 563 Computational Intelligence in Engineering
- ECE 564 Control and Operation of Electric Power Systems
- ECE 580 Elements of Sustainable Energy
- ECE 581 Elements of Smart Grid
- ECE 582 Microgrid Design and Operation

Master of Science in Computer Engineering

32 credit hours Thesis option

The purpose of this degree is to prepare students for advanced study and/or research or industrial practice in the field of computer engineering. The Master of Science in Computer Engineering (M.S.CP.E.) program builds a strong foundation in all aspects of the design and development of computer systems, with a specialization in a major area. Students have the option to pursue thesis research under the guidance of a faculty advisor. Areas of study include computer hardware design, computer networking and telecommunications, and computer system and application software. The program is normally completed in three semesters of full-time study.

The admission requirements for this degree follow the existing admission requirements for master's degrees in the ECE Department. Students whose accredited B.S. degree is not in computer engineering may pursue the M.S.CP.E., provided that they have an adequate background and can demonstrate proficiency in the material contained in the following undergraduate courses: ECE 211 and ECE 213 (Circuit Analysis I and II), ECE 218 (Digital Systems), ECE 242 or CS 350 (Digital Computers and Computing), ECE 311 (Engineering Electronics),

CS 201 (i.e., CS 115 and CS 116 combined, Object Oriented Programming I-II), CS 401 (Introduction to Advanced Studies in CS), MATH 251 (Multivariate and Vector Calculus), and MATH 252 (Introduction to Differential Equations). 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 credits of ECE short courses may be applied to the degree. Students, with advisor 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 following computer engineering (CPE) areas of concentration, and at least one core course from the remaining two areas. An M.S.CP.E candidate may, with permission of a thesis advisor, include in his or her 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.

CPE Areas of Concentration

I. Computer Hardware Design Core Courses

ECE 529 Advanced VLSI Systems Design AND/OR ECE 429 Introduction to VLSI Design AND ECE 585 Advanced Computer Architecture

Elective Courses

- ECE 425 Analysis and Design of Integrated Circuits
- ECE 429 Introduction to VLSI Design
- ECE 441 Microcomputers
- ECE 446 Advanced Logic Design
- $\rm ECE~485~$ Computer Organization and Design
- ECE 529 Advanced VLSI Systems Design
- ECE 530 High Performance VLSI/IC Systems
- ECE 583 High Speed Computer Arithmetic
- ECE 584 VLSI Architectures for Signal Processing and Communications
- ECE 585 Advanced Computer Architecture
- ECE 586 Fault Detection in Digital Circuits
- ECE 587 Hardware/Software Codesign
- ECE 588 CAD Techniques for VLSI Design
- ECE 589 Computer Aided Design of Analog IC

II. Computer Systems Software Core Courses

- CS 550 Comparative Operating Systems
- CS 551 Operating System Design and Implementation

Elective Courses

- ECE 449 Object-Oriented Programming and Computer Simulation
- ECE 587 Hardware/Software Codesign
- ${\rm CS}~487~~{\rm Software~Engineering~I}$
- CS 545 Distributed Computing Landscape
- CS 546 Parallel and Distributed Processing
- ${\rm CS}~550~~{\rm Comparative~Operating~Systems}$
- ${\rm CS}~551~~{\rm Operating}~{\rm System}~{\rm Design}~{\rm and}~{\rm Implementation}$
- CS 555 Analytic Models and Simulation of Computer Systems

- CS 586 Software Systems Architectures
- CS 587 Software Project Management
- CS 588 Advanced Software Engineering Development
- CS 589 Software Testing and Analysis

III. Networks and Telecommunications Core Courses

- ECE 407 Introduction to Computer Networks with Laboratory **OR**
- ECE 408 Introduction to Computer Networks
- ECE 541 Performance Evaluation of Computer Networks
- ECE 542 Design and Optimization of Computer Networks
- ECE 545 Advanced Computer Networks

Elective Courses

- ECE 407 Introduction to Computer Networks with Laboratory
- ECE 408 Introduction to Computer Networks
- ECE 443 Introduction to Computer Security
- ECE 504 Wireless Communication System Design
- ECE 508 Video Communications
- ECE 511 Analysis of Random Signals
- ECE 513 Communication Engineering Fundamentals
- ECE 514 Digital Communication Principles
- ECE 515 Modern Digital Communications
- ECE 519 Coding for Reliable CommunicationsECE 541 Performance Evaluation of Computer
- Networks
- ECE 542 Design and Optimization of Computer Networks
- ECE 543 Computer Network Security
- ECE 544 Wireless and Mobile Networks
- ECE 545 Advanced Computer Networks
- ECE 546 Wireless Network Security
- ECE 547 Wireless Networks Performance Analysis
- ECE 570 Fiber Optic Communication Systems
- ECE 584 VLSI Architectures for Signal Processing and Communications
- CS 455 Data Communications
- CS 544 Computer Networks II: Network Services

Master of Science in Computer Engineering and Electrical Engineering

Dual Degree, 45 credit hours Thesis Option

The purpose of the Master of Science in Computer Engineering and Electrical Enginering (M.S.CP.E/E.E.) is to prepare students for advanced study and/or research, or for industry in the fields of both computer and electrical engineering. The M.S.CP.E./E.E. program provides for a strong foundation in all aspects of the design and development of computer systems, and also offers several areas of study within electrical engineering. There is also an option to pursue thesis research under the guidance of a faculty advisor.

There is a growing need for engineers with a strong educational background in both computer engineering and electrical engineering. In the M.S.CP.E./E.E. program, students will be introduced to topics important to the computer engineering field, such as computer hardware design, computer networks, and software engineering, as well as topics in electrical engineering, such as communications and signal processing, electronics and electromagnetics, and power and control systems. The program of study includes a minimum of 45 credit hours of acceptable graduate coursework in both computer engineering and electrical engineering. M.S.CP.E./E.E. degree requirements are described in the section below. Requirements for the M.S.CP.E./E.E. fully satisfy the existing requirements for an M.S. in Computer Engineering and an M.S. in Electrical Engineering. The program is usually completed in four semesters of full-time study.

Admission requirements for the M.S.CP.E/E.E. are the same as those for admission to the Master of Science in Computer Engineering or Electrical Engineering. Students whose accredited B.S. degree is not in computer and/or electrical engineering may pursue the CPE/EE degree provided that they demonstrate proficiency in the material contained in the following undegraduate courses: ECE 211 and ECE 213 (Circuit Analysis I and II), ECE 218 (Digital Systems), ECE 242 or CS 350 (Digital Computers and Computing), ECE 307 (Electrodynamics), ECE 308 (Signals and Systems), ECE 311 (Engineering Electronics), CS 201 (i.e., CS 115 and CS 116 combined, Object Oriented Programming I-II), CS 401 (Introduction to Advanced Studies in CS), MATH 251 (Multivariate and Vector Calculus), and MATH 252 (Introduction to Differential Equations). 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 description of the CPE areas of concentration is in the Master of Science in Computer Engineering section. A description of the EE areas of concentration is in the Master of Science in Eletrical Engineering section.

In addition to all university requirements for a Master of Science degree, the M.S.CP.E./E.E. degree has the following requirements:

- 1. A minimum of 45 credit hours of graduate level coursework including the following:
 - (a) Two core courses in a CPE major area, chosen from among the CPE areas of concentration.
 - (b) Two elective courses in the CPE major area, chosen from among the CPE areas of concentration.
 - (c) One core course from each of the two remaining areas of CPE concentration.
 - (d) Four (or more) courses within an EE major area, chosen from among the EE areas of concentration (Areas I, II, and III).
 - (e) A minimum of two courses from two EE minor areas, chosen from among Areas I, II, and III outside the major.
 - (f) Additional coursework approved by the academic advisor.
- 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 course work 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 advisor.

Each regular (matriculated) graduate student is assigned an academic advisor, indicated in his/her formal letter of admission to the master's program.

Students should consult with their academic advisor to file a program of study meeting these requirements within three months after initial registration for fulltime students, and prior to enrolling beyond 12 credits for part-time students.

Master of Biomedical Imaging and Signals

30 credit hours

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 Biomedical Engineering Department and other disciplines at IIT which are of great importance to students interested in the professional master's degree in biomedical engineering, with specialization in medical imaging and bio-signals.

The admission requirements for the degree follow the existing admission requirements for other professional master's degrees in the ECE Department. Students whose accredited B.S. degree is not in electrical and computer engineering may pursue the professional master's degree provided that they have an adequate background and can demonstrate proficiency in the material contained in undergraduate courses equivalent to IIT's: ECE 211 and ECE 213 (Circuit Analysis I and II), ECE 218 (Digital Systems), ECE 307 (Electrodynamics), ECE 308 (Signals and Systems), ECE 311 (Engineering Electronics), BIOL 107 (General Biology Lectures), MATH 251 (Multivariate and Vector Calculus), MATH 252 (Introduction to Differential Equations), and MATH 474 (Probability and Statistics). 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

Required Courses

ECE 481 Image Processing AND/OR

ECE 565 Computer Vision and Image Processing

ECE 437 Digital Signal Processing I AND/OR

ECE 569 Digital Signal Processing II

ECE 511 Analysis of Random Signals

BIOL 430 Animal Physiology **OR**

BME 450 Animal Physiology

Imaging Elective Courses (1 course minimum)

ECE 507 Imaging Theory and Applications BME 430 Concepts of Medical Imaging BME 532 Medical Imaging Science

BME 535 Magnetic Resonance Imaging

BME 538 Neuroimaging

Signals Elective Courses (2 courses minimum)

ECE 505 Applied Optimization for Engineers

- ECE 566 Statistical Pattern Recognition
- ECE 567 Statistical Signal Processing
- ECE 568 Digital Speech Processing
- ECE 597 Special Project in Biomedical Imaging and Signals
- BME 501 Biomedical Instrumentation
- BME 551 Physiological Signal Analysis & Control Theory I
- BME 552 Physiological Signal Analysis & Control Theory II

With advisor's approval, students may take up to two senior (400 level) or graduate level courses in Engineering, Math, or Science.

Master of Electrical and Computer Engineering

 $30 \ {\rm Credit \ hours}$

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. Student's 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 undegraduate courses equivalent to IIT's: ECE 211 and ECE 213 (Circuit Analysis I and II), ECE 218 (Digital Systems), ECE 307 (Electrodynamics), ECE 308 (Signals and Systems), ECE 311 (Engineering Electronics), MATH 251 (Multivariate and Vector Calculus),

and MATH 252 (Introduction to Differential Equations). 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.

The program of study includes a minimum of 30 credit hours of acceptable graduate coursework, with a minimum of 24 credit hours in electrical and computer engineering, and a minimum of 18 credit hours at the 500-level or higher. Up to six credits of ECE short courses may be applied to the degree. Students arrange their program of study with their advisor'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.

Master of Network Engineering

30 credit hours

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 advisor approved coursework. The program offered by the Department of Electrical and Computer Engineering (ECE) can be completed in one year of full-time study.

The admission requirements for this degree follow the existing admission requirements for master's degree in the ECE department. A person holding a B.S.E.E. or a B.S.CP.E degree has the necessary background to undertake the M.N.E. program. A student without adequate background is required to demonstrate proficiency in the following courses: ECE 211 (Circuit Analysis I), ECE 213 (Circuit Analysis II), ECE 308 (Signals and Systems), MATH 251 (Multivariate and Vector Calculus), MATH 252 (Introduction to Differential Equations), and MATH 474 (Probability). 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 MNE elective courses, and 6 credit hours of advisor approved elective courses. At least 18 credit hours of the courses must be at the 500 level. A maximum of 6 credit hours may be taken from ECE 700 level short courses.

Curriculum

Required Courses (12 credit hours) Both of the following:

- ECE 511 Analysis of Random Signals
- ECE 513 Communication Engineering Fundamentals

One of the following:

- ECE 407 Introduction to Computer Networks with Laboratory
- ECE 408 Introduction to Computer Networks
- ECE 545 Advanced Computer Networks

One of the following:

- ECE 541 Performance Evaluation of Computer Networks
- ECE 542 Design and Optimization of Computer Networks

Elective Courses (12 credit hours)

This coursework is taken from the 400-, and 500-level courses listed below, and approved by the faculty advisor. A maximum of 6 credit hours of ECE short courses can be included in the M.N.E. program of studies.

ECE 403 Digital and Data Communications

OR

- ECE 405 Digital and Data Communications with Laboratory
- ECE 437 Digital Signal Processing I
- ECE 436 Digital Signal Processing I with Laboratory
- ECE 443 Introduction to Computer Security
- ECE 485 Computer Organization and Design
- ECE 504 Wireless Communication System Design
- ECE 508 Video Communications
- ECE 514 Digital Communication Principles
- ECE 515 Modern Digital Communications
- ECE 519 Coding for Reliable Communications
- ECE 541 Performance Evaluation of Computer Networks
- ECE 542 Design and Optimization of Computer Networks
- ECE 543 Computer Network Security
- ECE 544 Wireless and Mobile Networks
- ECE 545 Advanced Computer Networks
- ECE 546 Wireless Network Security
- ECE 547 Wireless Networks Performance Analysis
- ECE 565 Computer Vision and Image Processing
- ECE 568 Digital Speech Processing
- ECE 569 Digital Signal Processing II
- ECE 570 Fiber-Optic Communication Systems
- ECE 583 High Speed Computer Arithmetic
- ECE 584 VLSI Architectures for Signal Processing and Communications
- ECE 585 Digital Computer Design
- CS 455 Data Communications
- CS 548 Broadband Networks

Master of Power Engineering

 $30 \ {\rm credit \ hours}$

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 enginering.

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 IIT's: ECE 211 and ECE 213 (Circuit Analysis I and II), ECE 311 (Engineering Electronics), ECE 319 (Fundamentals of Power Engineering), MATH 251 (Multivariate and Vector Calculus), and MATH 252 (Introduction to Differential Equations). A student may demonstrate proffciency by successfully completing the courses or by demonstrating satisfactory performance in one or more special examinations administered by the ECE department.

The program of study includes a minimum of 30 credit hours of acceptable coursework with a minimum of 24 credit hours from the following list of core and elective courses (up to 6 credit hours may be selected from other ECE courses). A minimum of 18 credit hours at the 500level or higher must be selected. Up to 3 credit hours of a Graduate Special Project in power engineering (ECE 594 or ECE 597), and up to 6 credit hours of ECE short courses may be applied to the degree.

Curriculum

Core Courses (3 courses minimum)

- ECE 411 Power Electronics ECE 412 Electric Motor Drives
- ECE 420 Analytical Methods in Power Systems
- ECE 551 Advanced Power Electronics

One of the following:

ECE 418 Power Systems AnalysisECE 419 Power Systems Analysis with Laboratory

Elective Courses in Power Systems (2 courses minimum)

ECE 417 Power Distribution Engineering ECE 553 Power System Planning ECE 554 Power Systems Relaying ECE 555 Power Market Operations ECE 556 Power Market Economics and Security ECE 557 Fault-Tolerant Power Systems ECE 558 Power System Reliability ECE 559 High-Voltage Power Transmission ECE 560 Power Systems Dynamics and Stability ECE 561 Deregulated Power Systems ECE 562 Power System Transaction Management ECE 563 Computational Intelligence in Engineering ECE 580 Elements of Sustainable Energy ECE 581 Elements of Smart Grid ECE 582 Microgrid Design and Operation CHE 543 Energy, Environment and Economics

Elective Courses in Power Electronics and Motor Drives (2 courses minimum)

- ECE 437 Digital Signal Processing I
- ECE 438 Control Systems
- ECE 531 Linear System Theory
- ECE 538 Renewable Energies
- ECE 539 Computer Aided Design of Electric Machines
- ECE 548 Energy Harvesting
- ECE 549 Motion Control Systems Dynamics
- ECE 550 Power Electronic Dynamics and Control
- ECE 552 Adjustable Speed Drives
- ECE 762 Industrial Applications of Power Electronics and Motor Drives
- ECE 764 Vehicular Power Systems
- CHE 541 Renewable Energy Technologies

Master of VLSI and Microelectronics

30 credit hours

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 IIT's: ECE 211 and ECE 213 (Circuit Analysis I and II), ECE 218 (Digital Systems), ECE 307 (Electrodynamics), ECE 308 (Signals and Systems), ECE 311 (Engineering Electronics), MATH 251 (Multivariate and Vector Calculus), and MATH 252 (Introduction to Differential Equations). 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.

The program of study includes a minimum of 30 credit hours of acceptable coursework. Students can pursue a professional master's degree in the area of VLSI and microelectronics by completing the required core courses: ECE 425, ECE 429, ECE 529, and ECE 575 (and/or ECE 415) and selecting 6 additional courses from a combination of computer engineering electives, electronics electives, and other areas in electrical and computer engineering. A minimum of 18 credit hours at the 500-level or higher must be selected. With advisor 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.

Curriculum

Core Courses (4 courses minimum)

ECE 415 Solid-State Electronics

AND/OR

- ECE 575 Electron Devices ECE 425 Analysis and Design of Integrated Circuits
- ECE 429 Introduction to VLSI Design
- ECE 529 Advanced VLSI Systems Design

Elective Courses in Computer Engineering (1 course minimum)

- ECE 429 Introduction to VLSI Design
- $\rm ECE~485~$ Computer Organization and Design
- ECE 529 Advanced VLSI Systems Design
- ECE 530 High Performance VLSI/IC Systems
- ECE 542 Design and Optimization of Computer Networks
- ECE 545 Advanced Computer Networks
- ECE 583 High Speed Computer Arithmetic
- ECE 584 VLSI Architectures for Signal Processing and Communications
- ECE 585 Advanced Computer Architecture
- ECE 586 Fault Detection in Digital Circuits
- ECE 587 Hardware/Software Co-design
- ECE 588 CAD Techniques for VLSI Design
- ECE 589 Computer Aided-Design of Analog IC

Elective Courses in Electronics (1 course minimum)

- ECE 401 Communication Electronics
- ECE 425 Analysis and Design of Integrated Circuits
- ECE 521 Quantum Electronics
- ECE 524 Advanced Electronic Circuit Design
- ECE 525 RF Integrated Circuit Design
- ECE 526 Active Filter Design
- ECE 527 Performance Analysis of RF Integrated Circuits
- ECE 551 Advanced Power Electronics
- ECE 570 Fiber Optic Communication Systems
- ECE 571 Nanodevices and Technology
- ECE 575 Electron Devices
- ECE 578 Microwave Theory
Master of Telecommunications and Software Engineering

 $30 \ {\rm credit \ hours}$

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

Admission requirements for this degree follow the existing admission requirements for master's degrees in the ECE department. A person holding a B.S.E.E., a B.S.CP.E., or a B.S.C.S. degree has the necessary broad background to undertake the M.T.S.E. program. A student without adequate background in specifc areas is required to demonstrate proficiency in prerequisite courses: an abbreviated list is given below.

Specifc profeiency 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.

Computer Science Prerequisites

CS 201 (i.e., CS 115 and CS 116 combined, Object-Oriented Programming I-II)

 CS 401 $\,$ Introduction to Advanced Studies

Electrical and Computer Engineering Prerequisites

ECE 211 Circuit Analysis I

- ECE 213 Circuit Analysis II
- ECE 308 Signals and Systems

MATH 251 Multivariate and Vector Calculus

MATH 252 Introduction to Differential Equations

MATH 474 Probability and Statistics

The M.T.S.E. program of studies must include a minimum of 15 credit hours of ECE coursework and a minimum of 12 credit hours of computer science coursework. Five required courses and one elective course from each of the three categories given below must appear on the M.T.S.E. program of studies.

Curriculum

Required Courses

ECE 513 Communication Engineering Fundamentals

CS 586 Software Systems Architecture

CS 587 Programming Project Management

One of the following:

- ECE 407 Introduction to Computer Networks with Laboratory
- ECE 408 Introduction to Computer Networks

ECE 545 Advanced Computer Networks

One of the following:

- ECE 541 Performance Evaluation of Computer Networks
- ECE 542 Design and Optimization of Computer Networks

Elective Categories

I. Software Engineering

- ECE 449 Object-Oriented Programming and Computer Simulation
- CS 521 Object-Oriented Analysis and Design
- CS 537 Software Metrics
- CS 589 Software Testing and Analysis

II. Telecommunication Systems

- ECE 443 Introduction to Computer Security
- ECE 543 Computer Network Security
- ECE 544 Wireless and Mobile Networks
- ECE 546 Wireless Network Security
- ECE 547 Wireless Network Performance Analysis
- CS 544 Computer Networks II: Network Services
- CS 548 Broadband Networks
- CS 555 Analytic Models and Simulation of Computer Systems

III. Communications

- ECE 504 Wireless Communication System Design
- ECE 508 Video Communications
- ECE 514 Digital Communication Principles
- ECE 515 Modern Digital Communications
- ECE 519 Coding for Reliable Communications

The remaining nine credit hours of coursework may be taken from courses listed above, or other courses approved by the faculty advisor. Students without a background in communications or software engineering would be best prepared by including:

ECE 403 Digital and Data Communication Systems

- ECE 405 Digital and Data Communication Systems with Laboratory
- CS 487 Software Engineering I
- CS 450 Operating Systems I
- CS 455 Data Communications

Other recommended courses include:

- ECE 436 Digital Signal Processing I with Laboratory
- ECE 437 Digital Signal Processing I
- ECE 511 Analysis of Random Signals
- ECE 565 Computer Vision and Image Processing
- ECE 568 Digital Speech Processing
- ECE 569 Digital Signal Processing II
- ECE 584 VLSI Architectures for Signal Processing and Communications

CS 588 Advanced Software Engineering Development

With advisor approval, the M.T.S.E. program of studies can include up to four credit hours of ECE short courses.

Master of Electricity Markets

30 credit hours

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.

IIT's 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 IIT's: ECE 211 and ECE 213 (Circuit Analysis I and II), ECE 311 (Engineering Electronics), ECE 319 (Fundamentals of Power Engineering), MATH 251 (Multivariate and Vector Calculus), and MATH 252 (Introduction to Differential Equations). 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.

The program of study includes a minimum of 30 credit hours of acceptable graduate coursework, with a minimum of 15 credit hours from the area of engineering, and a minimum of 6 credit hours from the area of finance. A student can take MSF 502 or MSF 503, but only one can be counted toward the degree program. Six additional credit hours of electives are chosen from graduate coursework in the ECE department.

Curriculum

ECE Courses (minimum of 5 courses)

- ECE 417 Power Distribution Engineering
- ECE 418 Power Systems Analysis
- ECE 420 Analytical Methods in Power Systems
- ECE 553 Power System Planning
- ECE 555 Power Market Operations
- ECE 556 Power Market Economics and Stability
- ECE 557 Fault Tolerant Power Systems
- ECE 558 Power System Reliability
- ECE 561 Deregulated Power Systems
- ECE 562 Power System Transaction Management
- ECE 564 Control and Operation of Electric Power Systems
- ECE 580 Elements of Sustainable Energy
- ECE 581 Elements of Smart Grid
- ECE 582 Microgrid Design and Operation

Finance Courses (minimum of 2 courses)

- MSF 502 Statistical Analysis in Financial Markets
- MSF 504 Valuation and Portfolio Management
- MSF 505 Futures, Options, and OTC Derivatives
- MSF 524 Models for Derivatives
- MSF 526 Computational Finance
- MSF 534 Corporate Finance
- MSF 554 Market Risk Management
- MSF 564 Financial Theory
- MSF 584 Equity and Equity Derivatives Trading

Doctor of Philosophy in Electrical Engineering

84 credit hours, including master's degree studies Qualifying exam Comprehensive exam (dissertation proposal defense) Dissertation Oral dissertation defense

The doctorate 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 84 credit hours beyond the bachelor's degree, including the master's degree studies. A minimum of 24 credits are devoted to the student's research work, and a minimum of 24 credits 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 advisor 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 advisor, who may eventually serve as the thesis advisor 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 advisor, 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.

Doctor of Philosophy in Computer Engineering

84 credit hours, including master's degree studies Qualifying exam Comprehensive exam (dissertation proposal defense) Dissertation Oral dissertation defense

The doctorate 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 84 credit hours beyond the bachelor's degree, including the master's degree studies. A minimum of 24 credits are devoted to the student's research work, and a minimum of 24 credits 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 advisor 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 advisor, who many eventually serve as the thesis advisor 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 advisor, 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.

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

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

Elective Courses (choose four)

ECE 411 Power ElectronicsECE 425 Analysis and Design of Integrated Circuits

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. 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.

- ECE 521 Quantum Electronics
- ECE 524 Advanced Electronic Circuit Design
- ECE 525 RF Integrated Circuit Design
- ECE 526 Active Filter Design
- ECE 527 Performance Analysis of RF Integrated Circuits
- $\rm ECE~529~$ Advanced VLSI Systems Design
- ECE 530 High Performance VLSI/IC Systems
- ECE 571 Nanodevices and Technology
- ECE 575 Electron Devices

Required Courses

ECE 509 Electromagnetic Field Theory

AND one of the following:

- ECE 421 Microwaves Circuits and Systems
- ECE 423 Microwave Circuits and Systems with Laboratory

Elective Courses (choose two)

- ECE 522 Electromagnetic Compatibility
- ECE 571 Nanodevices and Technology
- ECE 576 Antenna Theory
- ECE 578 Microwave Theory

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

Required Courses

ECE 511 Analysis of Random Signals

ECE 513 Communication Engineering Fundamentals

Elective Courses (choose two)

- ECE 405 Digital and Data Communication Systems with Laboratory
- ECE 508 Video Communication
- ECE 514 Digital Communication Principles
- ECE 515 Modern Digital Communications
- ECE 519 Coding for Reliable Communications
- ECE 541 Performance Evaluation of Computer Networks
- ECE 542 Design and Optimization of Computer Networks
- ECE 543 Computer Network Security
- ECE 544 Wireless and Mobile Networks
- ECE 545 Advanced Computer Networks
- ECE 546 Wireless Network Security
- ECE 547 Wireless Network Performance Analysis

Computer Engineering

Graduates of this program gain proficiency in one of	ECE 485	Computer Organization and Design
several areas, including VLSI design, computer networks, $% {\displaystyle \sum} {\displaystyle \sum}$	ECE 530	High Performance VLSI/IC Systems
computer hardware, and software design. A maximum	ECE 541	Performance Evaluation of Computer
of one 400-level course may be taken, including ECE 429		Networks
if selected as a required course.	ECE 542	Design and Optimization of Computer
		Networks
Required Courses	ECE 543	Computer Network Security
ECE 585 Advanced Computer Architecture	ECE 544	Wireless and Mobile Networks
AND one of the following:	ECE 545	Advanced Computer Networks
ECE 429 Introduction to VLSI Design	ECE 546	Wireless Network Security
ECE 520 Advanced VI SI Systems Design	ECE 547	Wireless Networks Performance Analysis
Election Commenced (channel a)	ECE 583	High Speed Computer Arithmetic
Elective Courses (choose two)	ECE 584	VLSI Architectures for Signal Processing and
ECE 441 Microcomputers		Communications
ECE 443 Introduction to Computer Security	ECE 586	Fault Detection in Digital Circuits
ECE 446 Advanced Logic Design	ECE 587	Hardware/Software Codesign
ECE 448 Computer Systems Programming	ECE 588	CAD Techniques for VLSI Design
ECE 449 Object-Oriented Programming and Computer	ECE 589	Computer-Aided Design of Analog IC
Simulation		

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.

Required Courses

ECE 531	Linear System Theory
ECE 535	Discrete Time Control Systems
Elective C	Courses (choose two)
ECE 438	Control Systems
OR	
ECE 506	Analysis of Nonlinear Systems
ECE 550	Power Electronic Dynamics and Control

Electricity Markets

This program is an introduction to both the technical and business sides of a deregulated electric power industry. Students complete two courses from among power system electives and two courses from among finance electives.

Power System Courses (choose two)

- ECE 555 Power Market Operations
- ECE 556 Power Market Economics and Security
- ECE 561 Deregulated Power Systems
- ECE 562 Power System Transaction Management

Finance Courses (choose two)

- MSF 504 Valuation and Portfolio Management
- MSF 505 Futures, Options and OTC Derivatives
- MSF 554 Market Risk Management
- MSF 584 Equity and Equity Derivatives Trading

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.

Required Courses (choose two)

ECE 411 Power Electronics

ECE 550 Power Electronic Dynamics and Control

ECE 551 Advanced Power Electronics

ECE 552 Adjustable Speed Drives

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.

Core Course (choose one)

ECE 411 Power Electronics

ECE 412 Electric Motor Drives

- ECE 418 Power Systems Analysis
- ECE 419 Power Systems Analysis with Laboratory
- ECE 420 Analytical Methods in Power Systems

Elective Courses (choose two)

- ECE 437 Digital Signal Processing I
- ECE 438 Control Systems
- ECE 531 Linear System Theory
- ECE 535 Discrete Time Systems
- ECE 538 Renewable Energies
- ECE 539 Computer Aided Design of Electric Machines
- ECE 548 Energy Harvesting
- $\rm ECE~575~~Electron~Devices$

Elective Courses (choose three)

- ECE 417 Power Distribution Engineering
- ECE 538 Renewable Energies
- ECE 539 Computer Aided Design of Electric Machines
- ECE 540 Reliability Theory and System Implementation
- ECE 548 Energy Harvesting
- ECE 549 Motion Control Systems Dynamics
- ECE 550 Power Electronic Dynamics and Control
- ECE 551 Advanced Power Electronics
- ECE 552 Adjustable Speed Drives
- ECE 553 Power System Planning
- ECE 554 Power Systems Relaying
- ECE 555 Power Market Operations
- ECE 556 Power Market Economics and Security
- ECE 557 Fault-Tolerant Power Systems
- ECE 558 Power System Reliability
- ECE 559 High-Voltage Power Transmission
- ECE 560 Power Systems Dynamics and Stability
- ECE 561 Deregulated Power Systems
- ECE 562 Power System Transaction Management
- ECE 563 Computational Intelligence in Engineering
- ECE 564 Control and Operation of Electric Power Systems
- ECE 580 Elements of Sustainable Energy
- ECE 581 Elements of Smart Grid
- ECE 582 Microgrid Design and Operation

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.

Required Courses

ECE 511 Analysis of Random Signals ECE 569 Digital Signal Processing II

Elective Courses (choose two)

(no more	than one may be a 400-level course.)
ECE 436	Digital Signal Processing I with Laboratory
ECE 437	Digital Signal Processing I
ECE 481	Image Processing
ECE 507	Imaging Theory and Applications
ECE 508	Video Communications
ECE 565	Computer Vision and Image Processing
ECE 566	Statistical Pattern Recognition
ECE 567	Statistical Signal Processing
ECE 568	Digital Speech Processing
ECE 584	VLSI Architectures for Signal Processing and
	Communications

Wireless Communication 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.

Required Courses

ECE 504 Wireless Communication System DesignECE 513 Communication Engineering Fundamentals

Elective Courses (choose two)

- ECE 514 Digital Communication Principles
- ECE 515 Modern Digital Communications
- ECE 519 Coding For Reliable Communications
- ECE 544 Wireless and Mobile Networks
- ECE 546 Wireless Network Security
- ECE 547 Wireless Networks Performance Analysis
- ECE 576 Antenna Theory

Course Descriptions

ECE 502

Basic Network Theory

Steady-state analysis of linear networks. Introduction to topology and the derivation of mesh, nodal & terminal pair relations using topological concepts with applications to computer-aided analysis of networks. Numerical techniques for network analysis and optimization. (3-0-3)

ECE 504

Wireless Communication System Design

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

(3-0-3)

ECE 505

Applied Optimization for Engineers

Principles of optimization for practical engineering problems, linear programming, nonlinear unconstrained optimization, nonlinear constrained optimization, dynamic programming. (3-0-3)

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. (3-0-3)

(3-0-3)

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. (3-0-3)

ECE 508

Video Communications

This course covers the fundamentals of video coding and communications. The principles of source coding for the efficient storage and transmission of digital video will be covered. State-of-the-art video coding standards and error-resilient video coding techniques will be introduced. Recent technologies for robust transmission of video data over wired/wireless networks will be discussed. A detailed overview of architectural requirements for supporting video communications will be presented. Error control and cross-layer optimization techniques for wireless video communications will be covered.

Prerequisite(s): [(ECE 437 and ECE 511)] (3-0-3)

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)]

(3-0-3)

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.

Prerequisite(s): [(ECE 308 and MATH 474)]

(3-0-3)

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. Prerequisite(s): [(ECE 403 and MATH 474)] (3-0-3)

ECE 514

Digital Communication Principles

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

Prerequisite(s): [(ECE 511 and ECE 5 (3-0-3)

ECE 515

Modern Digital Communications

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

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

(3-0-3) 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.

Prerequisite(s): [(MATH 474)] (3-0-3)

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)] (3-0-3)

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)]

(3-0-3)

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.

 $\begin{array}{l} \mbox{Prerequisite(s): } [(ECE \ 309 \ and \ ECE \ 312)] \\ (3-0-3) \end{array}$

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. Requires senior standing.

Prerequisite(s): [(ECE 312)] (3-0-3)

ECE 526

Active Filter Design

Analysis and design of linear active filters with emphasis on realizations using operational amplifiers. Sensitivity analysis. Switched capacitor filters. Prerequisite(s): [(ECE 308 and ECE 312)]

(3-0-3)

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 intermodulation, cross-modulation, harmonics, gain compression, desensitization, spurious, etc. Noise effects including thermal, short, Flicker, burst noises, etc. RF IC devices and circuits including resistors, capacitors, inductors, diodes, BJTs, FETs, low-noise amplifiers, mixers, power amplifiers, etc. Analysis skills for single-stage and multiple-stage networks. RF IC team design projects. Requires senior standing. Prerequisite(s): [(ECE 312)] (3-0-3)

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 submicron design. Design projects are completed and fabricated by student teams.

Prerequisite(s): [(ECE 429)] (3-0-3)

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)]

(3-0-3)

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)] (3-0-3)

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)]

(3-0-3)

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)] (3-0-3)

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. (3-0-3)

ECE 540

Reliability Theory & 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. Prerequisite(s): [(ECE 308 and MATH 474)] (3-0-3)

Performance Evaluation of Computer Networks

Introduction to performance evaluation techniques for computer and communication networks. Little's theorem, birth-death processes, M/G/1 queue, product from queuing networks, approximation techniques for G/G/1 queues and non-product form queuing networks. Discrete event simulations, generation of random variables, variance reduction techniques and general purpose simulation languages.

Prerequisite(s): [(ECE 407 and MATH 474)] (3-0-3)

ECE 542

Design & 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)]

(3-0-3)

ECE 543

Computer Network Security

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

(3-0-3)

ECE 544

Wireless & Mobile Networks

This course provides an overview of different wireless and mobile network standards and systems. The topics covered include cellular networks, satellite networks, wireless local area networks, wireless personal area networks, mobile IP, ad hoc networks, sensor networks, wireless mesh networks and wireless network security.

Prerequisite(s): [(ECE 407) OR (ECE 408)] (3-0-3)

ECE 545

Advanced Computer Networks

Fundamentals of computer communication networks. Overview of data communication networks and protocol architectures with emphasis on the Internet protocols and network elements. Principles of network and protocol design; error detection and correction, flow control and congestion control, delay and throughput models, QoS, service support and application interface (including remote procedure call mechanisms). Local and Wide Area Networks (Ethernet, FDDI, Wireless LAN, ATM and Internet). LAN and Wan interconnection using bridges, routers, switchers and gateways. Routing in data networks. Network and protocol design to support multimedia and multicasting connections. Network application security.

Prerequisite(s): [(ECE 407) OR (ECE 408)] (3-0-3)

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)]

(3-0-3)

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)] (3-0-3)

ECE 548

Energy Harvesting

Various harvesting techniques such as solar, ocean ides, vibration, linear motion, radio frequency, passive and active human power generation are presented. Their operational principles are addressed. Research and simulations miniprojects with emphasis on power electronic circuit analysis, design, and controls are assigned to student groups. Prerequisite(s): [(ECE 311)]

(3-0-3)

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)] (3-0-3)

ECE 550

Power Electronic Dynamics & 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)]

Prerequisite(s): [(ECE (3-0-3)

(0-0-0)

ECE 551

Advanced Power Electronics

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

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)]

(2 0.2)

(3-0-3)

ECE 553

Power System Planning

Model development. Interchange capability, interconnections, pooling. Economic generator size and site selection. Concept of reserves, transformers, relays and circuit breakers. Reactive planning AC and DC systems are explored thoroughly from a planning standpoint.

Prerequisite(s): [(ECE 418) OR (ECE 419)] (3-0-3)

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, carrierpilot and microwave-pilot relaying systems. Solid-state relays and computer control of relaying. Determination of short-circuit currents and voltages from system studies. Prerequisite(s): [(ECE 418) OR (ECE 419)] (3-0-3)

ECE 555

Power Market Operations

Market Design in Restructured Power Systems, Short-term Load Forecasting, Electricity Price Forecasting, Price Based Unit Commitment, Arbitrage in Electricity Market, Market Power Analysis, Asset Valuation and Risk Analysis, Security Constrained Unit Commitment, Ancillary Services Auction Market Design, Power Transmission Pricing, Regional Transmission Organizations.

Prerequisite(s): [(ECE 418) OR (ECE 419)] (3-0-3)

ECE 556

Power Market Economics & 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, fuelswitching/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)] (3-0-3)

ECE 557

Fault-Tolerant Power Systems

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

(3-0-3)

ECE 558

Power System Reliability

The concept of reliability, reliability indices, component reliability, generation capacity reserve evaluation, transmission system reliability, bulk power system reliability, distributed system reliability, reliability modeling in context. Prerequisite(s): [(ECE 418) OR (ECE 419)] (3-0-3)

ECE 559

High Voltage Power Transmission

Detailed analysis of transmission and distribution systems. Design of high voltage transmission lines and cables, as well as distribution lines. Flexible AC transmission Systems (FACTS) and high voltage DC links. Prerequisite(s): [(ECE 418) OR (ECE 419)]

(3-0-3)

ECE 560

Power Systems Dynamics & Stability

The transient stability problem, acceleration equations, stability criteria, two-machine and multimachine problems. Perturbation analysis, eigenvalue sensitivity, Liapunov theory and application to power systems stability. Prerequisite(s): [(ECE 418) OR (ECE 419)]

(3-0-3)

ECE 561

Deregulated Power Systems

Overview of key issues in electric utilities restructuring, Poolco model, bilateral contracts, market power, stranded costs, transmission pricing, electric utility markets in the United States and abroad, OASIS, tagging electricity transactions, electric energy trading, risk in electricity markets, hedging tools for managing risks, electricity pricing, volatility in power markets, and RTO.

Prerequisite(s): [(ECE 418) OR (ECE 419)] (3-0-3)

ECE 562

Power System Transaction Management

Power interchange transaction management in the deregulated electric power industry. Course topics include: power system security assessment, total and available transfer capability (TTC/ATC), transaction management system (TMS), transaction information system (TIS), tagging calculator (IDC), congestion management, transmission loading relief (TLR).

Prerequisite(s): [(ECE 418) OR (ECE 419)] (3-0-3)

ECE 563

Computational Intelligence in Engineering

Introduction to soft computing, fuzzy set theory, neural networks, genetic algorithms, intelligent software agents, comparisons with traditional alternatives, and advanced engineering applications. (3-0-3)

ECE 564

Control & Operation of Electric Power Systems

Unit commitment and application of dynamic programming, fuel budgeting and planning, probabilistic production cost modeling, hydrothermal coordination, power system security and application of expert systems, state estimation, optimal power flow, interchange evaluation and power pools, reactive power planning.

Prerequisite(s): [(ECE 418) OR (ECE 419)] (3-0-3)

Computer Vision & 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).

Prerequisite(s): [(ECE 437 and MATH 474)] (3-0-3)

ECE 566

Statistical Pattern Recognition

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

(3-0-3)

ECE 567

Statistical Signal Processing

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

ECE 568

Digital Speech Processing

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

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.

Prerequisite(s): [(ECE 437 and MATH 474)] (3-0-3)

ECE 570

Fiber-Optic Communication Systems

Physics of optical fiber, composition, dimensioning, coupling, attenuation, dispersion. Electro-optical conversion devices. (ILDs, LEDs, APDs, PINs). Circuit considerations. Modulation techniques and implications. Overall system considerations. Coherent techniques.

 $Prerequisite(s): \ [(ECE 307 \ and \ ECE 312)] \ AND \ [(ECE 403)] \ (3-0-3)$

ECE 571

Nanodevices & Technology

Electronic properties and quantum effects. Dielectric, magnetic, and optical properties and their characterizations. Individual nanoparticles and clusters. Carbon nanotubes. Solid disordered nanostructures. Nanostructured crystals. Quantum wells, wires, and dots. Giant magnetoresistance. Material processing techniques. Devices and systems based on nanostructures. Prerequisite: Knowledge in quantum mechanics and thermodynamics. (3-0-3)

ECE 575

Electron Devices

Electronic properties of solids. Properties of p-n junctions and junction devices. Gunn diode and IMPATT devices. Junction transistors. Schottky diode and MESFET. The MOS capacitor and MOSFET. Light-emitting diodes and junction lasers. Velocity modulation and bunching in electron beams. Klystrons, magnetrons and other microwave thermionic devices.

Prerequisite(s): [(ECE 307 and ECE 312)]

(3-0-3)

ECE 576 Antenna Theory

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

ECE 578

Microwave Theory

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

ECE 580

Elements of Sustainable Energy

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

 $\begin{array}{l} \text{Prerequisite(s): [(ECE 418) OR (ECE 419) \\ (3-0-3) \end{array}$

ECE 581

Elements of Smart Grid

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

Microgrid Design & Operation

Microgrids are the entities that are composed of at least one distributed energy resource and associated loads which not only operates safely and efficiently within the local power distribution network but also can form intentional islands in electrical distribution systems. This course covers the fundamentals of designing and operating microgrids including generation resources for microgrids, demand response for microgrids, protection of microgrids, reliability of microgrids, optimal operation and control of microgrids, regulation and policies pertaining to microgrids, interconnection for microgrids, power quality of microgrids, and microgrid test beds.

Prerequisite(s): [(ECE 418) OR (ECE 419)] (3-0-3)

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, lowpower design, error analysis, and interval arithmetic.. Prerequisite(s): [(ECE 446) OR (ECE 485)]

(3-0-3)

ECE 584

VLSI Architecture for Signal Processing & Communication Systems

This course aims to convey knowledge of advanced concepts in VLSI signal processing. Emphasis is on the architectural research, design and optimization of signal processing systems used in telecommunications, compression, encryption and coding applications. Topics covered include the principles of datapath design; FIR and IIR filtering architectures; communication systems including OFDM, multirate signal processing; fast transforms and algorithms including fast Fourier transform; discrete cosine transform; Walsh-Hadamard transform; and wavelet transform. Furthermore, advanced computer arithmetic methods including Galois fields, CORDIC, residue number systems, distributed arithmetic, canonic signed digit systems and reduced adder graph algorithms are examined.

Prerequisite(s): [(ECE 429 and ECE 437)] (3-0-3)

ECE 585

Advanced Computer Architecture

Design, Analysis and Performance of High-Performance Computer Architectures; High Speed memory Systems: Cache Design and Analysis; Modeling Cache Performance; Instruction Level Parallelism, Cache-only Memory Architectures, Classification of Parallel Architectures; Systolic and Data Flow Architectures; Multiprocessor Performance; and Multiprocessor Iterations. (3-0-3)

ECE 586

Fault Detection in Digital Circuits

Essential elements in testing and testability of digital designs. Automatic tests generation algorithms and fault-simulation methods. Design methodologies to increase testability and decrease test generation costs. Techniques for built-in testing. Prerequisite(s): [(ECE 446)] (3-0-3) ECE 587

Hardware/Software Codesign

Computer-aided techniques for the joint design of hardware and software: specification, analysis, simulation and synthesis. Hardware/software partitioning, distributed system cosynthesis, application-specific instruction set design, interface cosynthesis, timing analysis for real-time systems.

Prerequisite(s): [(CS 201 and ECE 441)]

(3-0-3)

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)]

(3-0-3)

ECE 589

Computer-Aided Design of Analog IC

Analog IC design optimization algorithm such as equationbased 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. (3-0-3)

ECE 591

Research & Thesis for Masters Degree Research and thesis writing.

(Credit: Variable)

ECE 594

Special Projects Special projects. (Credit: Variable)

ECE 597

Special Problems Special problems. (Credit: Variable)

ECE 600

Continuation of Residence Continuation of residence. (0-0-1)

ECE 691

Research & Thesis for Ph.D. Research and thesis writing. (Credit: Variable)

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)]

(2-0-2)

ECE 719

Theory & Applications of Linear Optimization in Wireless Networks

This short course covers both the fundamental of linear optimization and applications in wireless networking research, emphasizing not only the optimization methodology but also the underlying mathematical structures. In addition to the fundamental contents of simplex method, duality theory, and network flow problems, this course also covers the integer programming techniques. This course discusses the applications of linear optimization in the wireless network, including wireless mesh networks, multi-radio multi-channel networks, and cognitive radio networks.

Prerequisite(s): [(ECE 407) OR (ECE 408)] AND [(MATH 477)] (2-0-2)

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. (1-0-1)

(1-0-1)

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. (2-0-2)

ECE 739

Broadband Access – Options & Analysis

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

(2-0-2)

ECE 740

Telecommunication Networks: Requirements to Deployment

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

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. (2-0-2)

ECE 743

Signal & 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. (2-0-2)

Embedded Digital Systems for Time-Frequency Distribution, Signal Modeling, & 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 timeseries frequency estimation, hardware/software codesign and realizations of time-frequency distributions, and signal modeling algorithms. (2-0-2)

ECE 752

Industrial Applications of Power Electronics & Motor Drives

Practical topologies of different types of power electronic converters are covered including industrial high-voltage and high-current applications, protection, and cooling. 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. (2-0-2)

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. (2-0-2)

ECE 756

Power System Maintenance Scheduling

This short course is aimed at providing an in-depth introduction to optimal generation and transmission maintenance in the regulated and restructured power systems. The basic principles of systems operation and economics related to maintenance scheduling will be discussed along with current practices and solution methods for the electric power industry.

Prerequisite(s): [(ECE 419 and ECE 420)] (2-0-2)

ECE 764

Vehicular Power Systems

Conventional electrical power systems of land, sea, air, and space vehicles are detailed along with the scope for improvement. New electrical loads and advanced distribution system architectures of electric and hybrid electric vehicles are presented. Current trends in the vehicular industry, such as 42V automotive systems and more electric aircraft, are explained. (2-0-2)

Undergraduate Courses Available to Graduate Students

Note: Students may take up to an approved number of the following courses.

ECE 401

Communication Electronics

ECE 403

Digital and Data Communication Systems

ECE 405

Digital and Data Communication Systems with Laboratory

ECE 407 Introduction to Computer Networks with Laboratory

ECE 408

Introduction to Computer Networks

ECE 411 Power Electronics

ECE 412 Electric Motor Drives

ECE 417 Power Distribution Engineering

ECE 418 Power System Analysis

ECE 419 Power Systems Analysis with Laboratory

ECE 420 Analytical Methods in Power Systems

ECE 421 Microwave Circuits and Systems

ECE 423 Microwave Circuits and Systems with Laboratory

ECE 425 Analysis and Design of Integrated Circuits

ECE 429 Introduction to VLSI Design

ECE 436 Digital Signal Processing I with Laboratory

ECE 437 Digital Signal Processing I

ECE 438 Control Systems

ECE 441 Microcomputers

ECE 443 Introduction to Computer Security

ECE 446 Advanced Logic Design

ECE 449 Object-Oriented Programming and Computer Simulation

ECE 481 Image Processing

ECE 485 Computer Organization and Design

Energy/Environment/Economics (E³)

Faculty Directors

Chemical and Environmental Engineering

Javad Abbasian 127 Perlstein Hall 10 W. 33rd St. Chicago, IL 60616 312.567.3047 abbasian@iit.edu

Mechanical, Materials and Aerospace

Engineering Herek Clack 252-D Engineering 1 10 W. 32nd St. Chicago, IL 60616 312.567.3184 clack@iit.edu

Electrical and Computer Engineering

Alexander J. Flueck 319 Siegel Hall 3301 S. Dearborn St. Chicago, IL 60616 312.567.3625 flueck@iit.edu

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,

Degrees Offered

Master of Chemical Engineering with E^3 specialization M.S. in Chemical Engineering with E^3 specialization

- Master of Electrical and Computer Engineering with E^3 specialization
- M.S. in Electrical Engineering with E^3 specialization (thesis and non-thesis options)
- Master of Environmental Engineering with E^3 specialization
- M.S. in Environmental Engineering with $\mathsf{E}^3\mathrm{specialization}$

Research Centers, Facilities, and Areas

Students should consult descriptions in the respective departments:

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.

IIT's Energy/Environment/Economics (E^3) program was developed to respond to the rapidly changing needs of the energy industry by providing the interdisciplinary research and training required to produce a new breed of engineer - one who specializes in energy technologies and who understands the associated environmental issues and economic forces that drive technology choice.

 E^3 specialization requires an interdisciplinary thesis in an E^3 area of research for M.S. and Ph.D. degrees, and an interdisciplinary graduate project for professional master's degrees. Graduate students in E³should also be enrolled in fundamental courses related to the topics of energy, environment, and economics. E^{3} is designed primarily for students majoring in chemical and environmental, mechanical and aerospace, or electrical engineering who are planning careers in energy-related fields. This interdisciplinary training prepares students to be not only creative and expert in a specialized area of energy extraction, conversion, or utilization, but also to possess a broad knowledge base of different energy sources, environmental issues related to energy extraction, conversion and utilization, and of the impact of industrial ecology principles on the design and operation of energy systems. Furthermore, students will gain sufficient knowledge of economic and regulatory issues to enable them to make more viable technology choices.

- Master of Mechanical and Aerospace Engineering with $\mathsf{E}^3\mathrm{specialization}$
- M.S. in Mechanical and Aerospace Engineering with $\mathsf{E}^3\mathrm{specialization}$
- Ph.D. in Chemical Engineering with $\mathsf{E}^3{\rm specialization}$ Ph.D. in Environmental Engineering with E^3 specialization

Ph.D. in Electrical Engineering with $\mathsf{E}^3{\rm specialization}$ Ph.D. in Mechanical and Aerospace Engineering with $\mathsf{E}^3{\rm specialization}$

Chemical and Biological Engineering Electrical and Computer Engineering Mechanical, Materials, and Aerospace Engineering

Admission Requirements

Students should consult listings in the respective departments:

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 E³specialization courses. The following section details the E^3 course requirements for M.S., professional master's, and Ph.D. degrees in chemical engineering, environmental engineering, mechanical and aerospace engineering, and electrical engineering. Selected E³undergraduate courses may be substituted for graduate courses with the approval of the designated advisor, if the total undergraduate credit hours for the professional master's or M.S. degree do not exceed departmental constraints.

Chemical and Biological Engineering Electrical and Computer Engineering Mechanical, Materials, and Aerospace Engineering

Students are also required to attend interdisciplinary seminars during their first and/or second semesters, which are offered as part of the regular graduate seminars by the departments of Chemical and Biological Engineering; Mechanical, Materials and Aerospace Engineering; and 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.

Master of Chemical Engineering with E³ Specialization

32 credit hours Project

This program has the same requirements as the M.S. degree program, except that, in place of six to eight credit

Master of Science in Chemical Engineering with E^3 Specialization

32 credit hours Thesis

Students pursuing the M.S. in Chemical Engineering with E^3 specialization are required to take CHE 543 and select at least one course from Group A and one course from Group B (listed in the E^3 course section of this bulletin), and register for up to eight credit hours

(CHE 594), plus additional E^3 courses with the approval of their advisor.

hours of M.S. thesis research, students are required to

register for two to five credits of special projects research

of M.S. thesis preparation (CHE 591) in an interdisciplinary E^3 area. In addition, the students are required to take all required core courses for the M.S. in Chemical Engineeering degree.

Students may apply up to 12 credit hours of 400-level courses to the M.S. degree requirements with their advisors approval.

Master of Environmental Engineering with E^3 Specialization

32 credit hours Project

This program has the same requirements as the M.S. degree program, except that in place of eight credit

hours of M.S. thesis research, students are required to register for two to five credits of special project research (ENVE 594), plus additional E^3 courses with the approval of their advisor.

Master of Science in Environmental Engineering with E^3 Specialization

32 credit hours Thesis

Candidates for the M.S. in Environmental Engineering with E^3 specialization are required to take ENVE 544 and complete the required core courses for the M.S. in Environmental Engineering degree. In addition, students must complete one course from Group A, and one from Group B (listed in the E^3 course section of this bulletin).

Students are also required to register for up to eight credit hours of M.S. thesis research (ENVE 591) in an interdisciplinary E^3 area. Students may apply up to two 400-level courses to the M.S. degree requirements with their advisor's approval.

Master of Mechanical and Aerospace Engineering with E^3 Specialization

30 credit hours

Candidates for the Master of Mechanical and Aerospace Engineering with E^3 specialization are required to take CHE 543 and the following three courses:

MMAE 501 Engineering Analysis I MMAE 520 Advanced Thermodynamics MMAE 523 Fundamentals of Power Generation In addition, the E^3 specialization under MMAE requires a course emphasizing numerical methods, 2 courses selected from the following Group A courses, and one Group B course, in the E^3 course section of this bulletin.

MMAE 521 Statistical ThermodynamicsMMAE 524 Fundamentals of CombustionMMAE 525 Fundamentals of Heat TransferMMAE 526 Heat Transfer: ConductionMMAE 527 Heat Transfer: Convection and Radiation

Master of Science in Mechanical and Aerospace Engineering with ${f E}^3$ Specialization

32 credit hours Thesis

Candidates for the M.S. in Mechanical and Aerospace Engineering with E^3 specialization are required to take CHE 543 and two courses: MMAE 501 (Engineering Analysis I) and MMAE 502 (Engineering Analysis II). Also required under the thermal sciences area of MMAE are MMAE 520 (Advanced Thermodynamics), MMAE 523 (Fundamentals of Power Generation) and any two of the following Group A courses:

MMAE 521 Statistical Thermodynamics MMAE 524 Fundamentals of Combustion MMAE 525 Fundamentals of Heat Transfer MMAE 526 Heat Transfer: Conduction MMAE 527 Heat Transfer: Convection and Radiation Also required are one course from Group B and six to eight credit hours of MMAE 591 (Thesis).

Master of Electrical and Computer Engineering with E^3 Specialization

30 credit hours Non-thesis option

This program has the same requirements as the M.E.C.E. degree program, except that students are required to register for three to six credits of special project research (ECE 594 or ECE 597), plus CHE 543, two courses from the electrical engineering courses listed in Group A, one course from Group B (listed in the E^3 course section of this bulletin), and two power and control courses. At least 24 ECE credits are required.

Master of Science in Electrical Engineering with E^3 Specialization

32 credit hours Thesis option

Candidates for the M.S. in Electrical Engineering are required to take CHE 543 and must select two courses from the electrical engineering courses listed in Group A and one course from Group B (listed in the E^3 course section of this bulletin). In addition, students are required to take two power and control courses, and at least one course from each of two minor areas of study:

Doctor of Philosophy with E^3 Specialization

84 credit hours Qualifying exam Comprehensive exam Dissertation and oral defense

Students interested in the Ph.D. program in all disciplines (chemical, environmental, mechanical, materials and aerospace, and electrical engineering) are required to take at least 84 credit hours beyond the B.S. degree requirements, including CHE 543, and at least five

E³ Courses

See descriptions under the respective department's course listings.

Group A

CHE 503 Thermodynamics

CHE 536 Computational Techniques in Engineering

CHE 541 Renewable Energy Technologies

CHE 542 Fluidization and Gas-Solids Flow Systems

CHE 565 Fundamentals of Electrochemistry

ECE 550 Power Electronic Dynamics and Control

ECE 551 **Advanced Power Electronics**

ECE 552 Adjustable Speed Drives

ECE 553 **Power System Planning**

ECE 554 Power System Relaying

ECE 555 **Power Market Operations**

ECE 557 **Fault-Tolerant Power Systems**

ECE 558 Power System Reliability communication theory and signal processing, network electronics and electromagnetics, or computer engineering. The students are also required to register for six to eight credit hours of M.S. thesis research (ECE 591) in an interdisciplinary E³area and one advanced math course (unless this requirement was met in the B.S. degree). Students may apply up to 12 credit hours of 400-level courses toward the M.S. degree, with their advisor's approval.

 E^{3} courses (four from both groups A and B; see course listings within the E^3 section of this bulletin) upon the recommendation of their thesis advisor. Registration for approximately 32 hours of Ph.D. thesis research in E³areas of study is also required. Candidates must pass written qualifying and comprehensive examinations and must defend their thesis in an oral examination. The Ph.D. committee for E^3 students must include at least one E^3 professor from outside the student's department.

ECE 559 High Voltage Power Transmission
ECE 560 Power Systems Dynamics and Stability
ECE 561 Deregulated Power Systems
ECE 562 Power System Transaction Management
ECE 563 Computational Intelligence in Engineering
ECE 564 Control and Operation of Electric Power Systems
MMAE 517 Computational Fluid Dynamics
MMAE 520 Advanced Thermodynamics
MMAE 521 Statistical Thermodynamics
MMAE 522 Nuclear, Fossil-Fuel, and Sustainable Energy Systems
MMAE 523 Fundamentals of Power Generation
MMAE 524 Fundamentals of Combustion
MMAE 525 Fundamentals of Heat Transfer
MMAE 526 Heat Transfer: Conduction
MMAE 527

Heat Transfer: Convection and Radiation

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MMAE 538 Computational Techniques in Finite Element Methods

MMAE 539 Nonlinear Finite Elmnt Anlys

Group B

CHE 541 Renewable Energy Technologies

CHE 560 Statistical Quality and Process Control

EM 507 Industrial Ecology

ENVE 501 Environmental Chemistry

ENVE 506 Chemodynamics

ENVE 520 Environmental Monitoring and Assessment

ENVE 527 Statistical Analysis of Systems

ENVE 542 Physiochemical Processes in Environmental Engineering ENVE 545 Environmental Regulations and Risk Assessment

ENVE 551 Industrial Waste Treatment

ENVE 561 Design of Environmental Engineering Processes

ENVE 563 Systems Engineering: Waste Facility Design and Operation

ENVE 570 Air Pollution Meteorology

ENVE 573 Air Pollution Engineering

ENVE 577 Design of Air Pollution Control Devices

ENVE 578 Physical and Chemical Processes for Industrial Gas Cleaning

ENVE 580 Hazardous Waste Engineering

ENVE 585 Groundwater Contamination and Pollutant Transport

Food Safety and Technology

Institute for Food Safety and Health IIT Moffett Campus 6502 S. Archer Road Bedford Park, IL 60501 708.563.8271 708.563.8274 (fax) www.iit.edu/ifsh

IIT Vice President and IFSH Director: Robert Brackett

IFSH Associate Director:

Jason Wan

Graduate Program Manager:

Renee McBrien

The Institute for Food Safety and Health (IFSH), with IIT faculty, U.S. Food and Drug Administration (FDA) scientists, and food industry experts, provides a unique training ground for individuals seeking graduate education in food safety and technology and food process engineering. Courses are offered at IFSH with the strong support of the following IIT departments: Biological and Chemical Sciences (BChS) and Chemical and Biological Engineering (ChBE).

The master's degree programs in Food Process Engineer-

Degrees Offered

Master of Science in Food Safety and Technology (Thesis Option) Master of Food Safety and Technology (Professional, Non-Thesis Option) Master of Science Food Process Engineering

(Thesis Option)*

Certificate Programs

Food Safety and Technology Food Process Engineering* Food Processing Specialist* ing (FPE) are designed as flexible programs 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 foods 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.

The teaching faculty is drawn from IFSH/IIT faculty and IFSH/FDA scientists, and is augmented by IIT faculty from several departments, together with scientists and experts from the private sector. In addition to the formal course requirements, students may participate in food safety and technology research projects at the IFSH under the supervision of IIT faculty and FDA scientists. The FDA presence provides a unique opportunity for students to understand the synergy of scientific philosophy and legal issues involved in the regulatory process governing the safety and wholesomeness of the food supply.

Master of Food Process Engineering (Professional, Non-Thesis Option)*

* Please refer to Chemical and Biological Engineering Department

* Please refer to Chemical and Biological Engineering Department

Facilities

The IFSH facilities include a 2,692 square meter industrial scale pilot plant. The pilot plant 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. A separate Biosafety Level-3 (BSL-3) Biocontainment Pilot Plant (BCPP) provides 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.

Faculty

Brackett, Robert E., Professor of Biology in the School of Applied Technology, Vice President, and Director of the Institute for Food Safety and Health (IFSH). B.S., M.S., Ph.D. University of Wisconsin-Madison. Microbiological food safety; growth and survival of psycrotrophic pathogens in foods; physical/chemical controls for pathogens in foods; and microbial ecology of plant products.

Burton-Freeman, Britt, Research Assistant Professor of Biology, Director of the Nutrition Center at IFSH. B.S. California State University; M.S., Ph.D. University of California-Davis. Appetite and obesity management and vascular disease. Research emphasizes on the effects of bioactive food components on mechanistic and behavioral processes of food intake and body weight regulation. Properties of fibers, micro- and macro-molecule interactions, and food matrix effects in the gut to alter metabolic and endocrine systems. Effects of dietary constituents on vascular diseases including evaluation of endothelium function, platelet activation, inflammatory and oxidative stress responses during acute and chronic interventions. The research approach includes human and basic science methodology.

Cappozzo, Jack, Director of Chemistry, IFSH/IIT. M.S., Illinois Institute of Technology. Analytical chemistry with emphasis on separation science using high performance liquid chromatography (HPLC) and gas chromatography (GC) coupled to mass spectrometry (MS). Interest has been on new methods of analysis using HPLC-MS/MS to detect ultra-low levels of vitamins, flavonoids, and other phenolic antioxidants in foods and clinical serum samples to support clinical trials. In addition, core work is also performed in the areas of allergen cleaning and methods.

Edirisinghe, Indika , Research Assistant Professor and Senior Scientist of the Nutrition Center at the Institute for Food Safety and Health. B.Sc., University of Delphi (India); M.Phil., Ph.D., University of Peradeniya (Sri Lanka). Effect of polyphenolic compounds on endothelial function, blood pressure regulation, platelet function, insulin resistance, inflammatory and oxidative stress responses during acute and chronic interventions. The research approach includes human cell culture, animal models and human clinical trials. Grove, Stephen F., Research Assistant Professor of Biology and Scientist at the Institute for Food Safety and Health. B.App.Sci. & B.App.Sci. (Hons.), RMIT University (Australia); Ph.D, University of Tasmania (Australia.). Microbial food safety; fresh produce and sprout safety; cross-contamination, inactivation and detection of enteric viruses during food processing and handling; use of novel processing and sanitation techniques for fresh-cut produce; and survival and inactivation of bacterial pathogens in low moisture foods.

Krishnamurthy, Kathiravan, Research Assistant Professor of Chemical Engineering. B.E., Tamil Nadu Agricultural University (India); M.S.,Ph.D., Pennsylvania State University. Food engineering, novel and emerging food processing technologies, simulation and modeling of food processes, food safety, thermal processing technologies.

Lee, Alvin, Research Associate Professor of Biology and Director of Microbiology at IFSH. B.App.Sci., Ph.D, RMIT University (Australia). Microbial food safety, food virology, molecular detection and quantification of enteric pathogens; molecular characterization of virulence mechanisms, cell culture, intervention strategies for foodborne pathogens.

Wan, Jason, Research Professor and Director of Education and International Outreach at the Institute for Food Safety and Health. B.S., Hunan University; M.S., Northeast Agricultural University; Ph.D., Deakin University (Australia). Molecular microbiology including development of DNA-based methods for detection, differentiation and tracking of foodborne pathogens in food systems and environment. Emerging nonthermal processing technologies, including high pressure processing (HPP), pulsed electric field (PEF), ultrasound, UV and non-thermal plasma, for microbial inactivation, shelf-life extension and food safety enhancement. Dairy processing, protein chemistry, and development and evaluation of bioactive dairy ingredients for functional food applications.

Wasan, Darsh T., Distinguished Motorola Professor of Chemical Engineering and Vice President for International Affairs, . B.S., University of Illinois, Urbana-Champaign; Ph.D., University of California-Berkeley. Thin liquid films, foams, emulsions and nanoparticle suspensions, film rheology and applications, wetting, spreading and adhesion of nano-fluids on solid surfaces, environmental technologies, food colloids.

Zhang, Wei, Associate Professor. B.S., M.S., Huazhong Agricultural University; Ph.D., Pennsylvania State University. Molecular detection, genotyping, epidemiology, virulence and pathogenesis of foodborne bacteria. Microbiology, Biotechnology.

Adjunct Faculty

Schell, Rich, Adjunct Professor, Food Law and Regulation, IFSH/IIT. B.A., Illinois Wesleyan University J.D., Southern Illinois University. International food and agriculture; agricultural and food entrepreneurship, including organics and green/sustainability initiatives; food and farm traceability; farmland ownership; legal and regulatory compliance as a competitive advantage for food companies and entrepreneurs..

Admission Requirements

Cumulative undergraduate GPA minimum: 3.0/4.0

- 1. GRE score for Master of Science Degree 1100 (quantitative + verbal) and 2.5 analytical writing
- 2. New GRE score 304 (Thesis required)
- 1. GRE score for Professional Master (Non-Thesis Option) 950
- 2. New GRE score 295
- 3. TOEFL minimum: 550/213/80*

Program Descriptions

Students in Food Safety and Technology programs should consult with their faculty advisor to plan a program of study best suited to their background and interests. The Food Safety and Technology program is directed toward students with backgrounds in food science and related fields. The Food Process Engineering (FPE) programs are directed toward students with background and career objectives in engineering-related disciplines. Students enrolled in FST Master of Science programs must register for six to eight credit hours of research. This work will usually be conducted at the Moffett Campus; * Paper-based test score/computer-based test score/internet-based test score.

research topics will be selected from food safety, food process engineering, food biotechnology, or related topics. Attendance will also be required in a graduate seminar where students are expected to actively participate and present reports on their research. Students enrolled in Master of Food Safety and Technology and Master of Food Process Engineering are strongly encouraged to do an independent project up to four credit hours. Details on food process engineering program requirements are in the section on the Department of Chemical and Biological Engineering.

Master of Science in Food Safety and Technology

Thesis Required

32 credit hours

M.S. Thesis Defense (Written Thesis Report and Oral Defense Required)

Candidates are required to take a total of 32 credit hours, 18 of which must be selected from the core food safety and technology courses listed below, 6-8 credit hours must be in research and thesis work and 6-8 credit hours from electives.

Core Course Requirements (18 credit hours)

- FST 505 Food Microbiology
- FST 506 Food Microbiology Laboratory
- FST 507 Food Analysis
- FST 521 Food Process Engineering
- FST 524 Fundamentals of Food Science and Technology

FST 541 Principles of Food Packaging

Core Research Thesis Requirement (6-8 credit hours)

FST 591 Research and Thesis for M.S. Degree

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 IIT faculty members from various departments, IFSH/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. As a part of the thesis, the student is expected to contribute scholarly article(s) to one or more high quality peer-reviewed journal). The student is also encouraged to present the research at a national professional society meeting.

Electives (6-8 credit hours)

- FST 501 Nutrition Metabolism and Health
- FST 502 Research Project: Design, Delivery and Dissemination
- FST 504 Food Biotechnology
- FST 511 Food Law and Regulation
- FST 531 HACCP Planning and Implementation
- FST 593 Seminar Series
- FST 594 Special Projects (dependent upon number of thesis credits taken, please consult IFSH Academic Advisor)
- FST 597 Special Problems (dependent upon number of thesis credits taken, please consult IFSH Academic Advisor)

Students may enroll in FST 594 and FST 597 up to a maximum of 2 credit hours between both courses when enrolled in 6 credits of thesis; or 7 credit hours when enrolled in 1 credit hour of thesis. However, if the 597 is used as a short course, the student can register up to 4 credits in 597 with IFSH advisor approval. Students may not enroll in FST 594 or 597 when using 8 credits of thesis unless 597 is used as a short course (up to 4 credits with IFSH advisor approval).

Students must have a minimum grade point average of 3.0/4.0. In addition to the core courses required and electives of all students, further courses may be selected from the Biological and Chemical Sciences Department (BChS) and the Chemical and Biological Engineering Department (ChBE) with the approval of the IFSH advisor, to fit the background and needs of the individual student.

Master of Food Safety and Technology

Professional, Non-Thesis Option

Candidates are required to take a total of 32 credit hours, 15-18 credit hours of which must be selected from the core food safety and technology courses listed below, and 14-17 credit hours must be selected from electives. Courses are offered at IFSH or via internet with the exception of FST 506, FST 593, FST 594, and FST 597.

Core Courses (15-18 credit hours)

- FST 505 Food Microbiology
- FST 506 Food Microbiology Laboratory (Required unless student has enough professional background experience to substitute, decision will be made by the IFSH Graduate Program Director.)
- FST 507 Food Analysis
- FST 521 Food Process Engineering
- FST 524 Fundamentals of Food Science and Technology
- FST 541 Principles of Food Packaging

Electives (14-17 credit hours)

- FST 501 Nutrition Metabolism and Health
- FST 502 Research Project: Design, Delivery and Dissemination
- FST 504 Food Biotechnology
- FST 511 Food Law and Regulation
- FST 522 Advanced Food Process Engineering
- FST 531 HACCP Planning and Implementation
- FST 593 Seminar Series
- FST 594 Special Projects
- FST 597 Special Problems

Students can enroll in FST 594 and 597 with a maximum of 6 credit hours total between both courses with an IFSH advisor approval. However, when 597 is used as a short course, the total credit hours must not exceed 8 between 594 and 597 combined. The student must have a minimum grade point average of 3.0/4. In addition to the core courses required of all students, further courses from the Biological and Chemical Sciences Department (BChS) and the Chemical and Biological Engineering Department (ChBE) may be selected with the approval of the IFSH advisor to fit the background and needs of the individual student.

Certificate Programs

Food Safety and Technology (FST)

 $12\ {\rm credits}$

The certificate programs provide a student with post baccalaureate knowledge of food safety and technology and its applications in the food industry, and in federal and state public health agencies. Certificate programs typically require a set of three to four courses that must be completed in three years with minimum GPA of 3.0/4.0. Students who are admitted to master's degree programs may apply coursework previously taken in a certificate program towards the requirements for the masters degree. Courses are offered via internet, with the exception of FST 506.

Food Process Engineering (FPE)

Food Processing Specialist

 $12\ {\rm credit}\ {\rm hours}$

Students should refer to the Department of Chemical and Biological Engineering for additional details.

Four Courses from the following (12 credit hours)

	FST 501	Nutrition	Metabolism	and	Health
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- FST 504 Food Biotechnology
- FST 505 Food Microbiology
- FST 506 Food Microbiological Laboratory
- FST 507 Food Analysis
- FST 521 Food Process Engineering
- FST 524 Fundamentals of Food Science and Technology
- FST 531 HACCP Planning and Implementation
- FST 541 Principles of Food Packaging

Course Descriptions

Numbers in parentheses indicate class, lab, and credit hours, respectively.

FST 501

Nutrition, Metabolism, & Health

Study of structures, types, and metabolism of carbohydrates, lipids, and proteins. Discussion of the biological roles of vitamins and minerals. Application and integration of metabolic knowledge with health promotion and chronic disease. (3-0-3)

FST 502

Research Project: Design, Delivery, & Dissemination

This course is an introduction to designing, confucting, and reporting on scientific research. Topics will include defining a problem and creating a research proposal, experimental design, data collection and analysis, and a written and oral presentation of results.

(3-0-3)

FST 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. Prerequisite: Biology or Microbiology. (3-0-3)

FST 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. Core course. Prerequisite: Introductory Microbiology or Food Science. (3-0-3)

FST 506

Food Microbiological Lab

Introductory Microbiology. Basic microbiological techniques and safe laboratory practices. Introductory Food Microbiology. Isolation pathogenic bacteria. Spoilage microorganisms. Fermentation. Environmental Monitoring. Rapid Identification tests. Sporeformers. Prerequisite: Microbiology or Food Science. (0-3-3)

FST 507

Food Analysis

Techniques for analyzing food toxins, food constituents of public health concern, intentional and unintentional food additives, modern separation and analytic techniques. (2-3-3)

FST 511

Food Law 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.

(3-0-3)

FST 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. (3-0-3)

FST 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 Instructor processing techniques and safety implications. permission is required.

Prerequisite(s): [(FPE 520) OR (FPE 521) OR (FST 521)] (3-0-3)

FST 524

Fundamentals in Food Science & Technology

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. (3-0-3)

FST 531

HACCP Planning & 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. (3-0-3)

FST 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. (3-0-3)

FST 591

Research & Thesis

Research and thesis for master of science students. Minimum 6 credits required. (Credit: Variable)

FST 593

Seminar on Food Safety & Technology

Students attend seminars offered during the semester. Each student is also required to give a 30 minute presentation on a topic of his/her interest or a research project on which she/he has worked. (Credit: 1 Hour)

(1-0-1)

FST 594

Special Projects

Advanced projects involving analysis of food safety processing, packaging and biotechnology systems. (Credit: 1-6 hours). (Credit: Variable)

FST 597 Special Problems

Independent study focusing on current problems, issues of professional relevance. Topics selected from food process engineering, food safety, packaging, biotechnology. Repeatable to a maximum of four credit hours. (Credit: 1-6) (Credit: Variable)

FST 600

Continuing of Residence Continuing of residence.

(1-0-1)

FST 772

Design & Development of Food Products

Methodologies for designing and developing food products, assessment of alternatives for low-fat, low-calorie food product alternatives, substitute ingredients, market evaluation, process modification. Development of prototypes, process optimization and evaluating consumer acceptance. Impact of microbiology, sanitation and nutrition on product development. (3-0-3)

Department of Humanities

Program in Technology and the Humanities

Siegel Hall 218 3301 S. Dearborn St. Chicago, IL 60616 312.567.3465 humoffice@gmail.com www.iit.edu/csl/hum/programs/grad

Chair: Maureen Flanagan, Department of Humanities

Co-Directors, Graduate Studies: Matthew Bauer Karl Stolley gradhuminfo@iit.edu The Department of Humanities' Graduate Program in Technology and Humanities prepares students for careers in emerging forms of technology-driven human communication, collaboration, and learning. Students have the opportunity to pursue a course of study and participate in faculty-led research projects in areas such as user experience design, web development, social networks, and content strategy. 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.

Master of Science in Information Architecture

Doctor of Philosophy in Technical Communication

Degrees Offered

Master of Science in Technical Communication and Information Design

Certificate Programs

Instructional Design Technical Communication

Research Facilities

The department supports a Usability Testing and Evaluation Center; an editing center, Edit IIT; the Collaboration and Social Media Lab @ IIT (CaSM Lab); Gewgaws Lab, a physical and virtual design production lab focused on open source; and a Speech Analysis Lab for applied research on natural and synthesized speech. IIT'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 IIT campus, some of which also

serve as classrooms for technical communication courses.

Research Areas

Humanities department faculty conduct research in a wide range of areas. Among those especially relevant to technical communication are aesthetics; document and online design; ethics in the professions; history of art and architecture; humanizing technology; information seeking and retrieval; instructional design; intellectual property; knowledge management; linguistics; philosophy of science; rhetorical theory; social media; text analysis; and usability testing.

Faculty

Bauer, Matthew J., Associate Professor of Linguistics and Co-Director of Graduate Studies. B.A., University of Minnesota-Duluth; M.S., Ph.D., Georgetown University.

Dabbert, James, Senior Lecturer of English, Director of Humanities Writing Center, and Associate Director for ESL Programs. B.A., M.S., Indiana University.

Davis, Michael, Professor of Philosophy. B.A., Western Reserve University; M.A., Ph.D., University of Michigan.

Flanagan, Maureen A., Professor of History and Chair of the Department of Humanities. B.A., Dominican College; Ph.D., Loyola University of Chicago.

Glassman, Ellen C., Senior Lecturer of Art and Architectural History. B.A., M.A., University of Cincinnati; Ph.D., Northwestern University.

Hemphill, Libby, Assistant Professor of Communication and Information Sciences. A.B., University of Chicago; M.S., Ph.D., University of Michigan.

Hicks, Marie, Assistant Professor of History. A.B., Harvard University; M.A., Ph.D., Duke University.

Kocurek, Carly A., Assistant Professor of Digital Humanities and Media Studies. B.A., Rice University; M.A., Ph.D., University of Texas. Otterbacher, Jahna, Assistant Professor of Communication and Information Sciences. B.A., M.A., Ph.D., University of Michigan; M.A., Boston University.

Power, Margaret, Professor of History and Chair of the Pre-Law Advisory Committee. B.A., Georgetown University; M.A., San Francisco State University; Ph.D., University of Illinois.

Pulliam, Gregory J., Senior Lecturer of Communication, Rhetoric, and Linguistics, Director of English as a Second Language Programs, Undergraduate Advisor, and Associate Chair, Department of Humanities. B.A., Memphis State University; M.A., Ph.D., University of Missouri.

Schmaus, Warren S., Professor of Philosophy. A.B., Princeton University; M.A., Ph.D., University of Pittsburgh.

Snapper, John W., Associate Professor of Philosophy and Academic Policy Coordinator. B.A., Princeton University; M.A., Ph.D., University of Chicago.

Stolley, Karl A., Associate Professor of Digital Writing and Rhetoric and Co-Director of Graduate Studies, Department of Humanities. B.A., Millikin University; M.A., Ph.D., Purdue University.

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

Admission Guidelines (Ph.D. Program)

The doctoral program in technical communication at IIT prepares students for careers in research and teaching at the postsecondary level, as well as for advanced supervisory and research positions in business and government. Building on a base of skills in workplace practices, the program incorporates theory-oriented advanced readings, seminars, and dissertation research leading to original contributions to scholarship in the field.

Students enter the Ph.D. program from a wide range of fields, but should have substantial academic preparation or professional experience related to technical communication.

Applicants must have completed a bachelor's or master's degree in a field that, in combination with the 27-credithour technical core, would provide a solid basis for advanced academic work leading to original research in the field. The relevance of previous degrees to the doctoral program will be assessed by the department's graduate admissions committee.

In addition to the application form, the applicant must submit the following:

- 1. Professional statement discussing the applicant's research interests and plans for graduate study, research interests, and goals
- 2. Three letters of recommendation from faculty or supervisors who can evaluate the applicant's po-

All applicants are required to submit Graduate Record Exam (GRE) scores with a minimum combined score of 1000 quantitative + verbal (with a minimum score of 500 in each area) and 3.0 (analytical writing). Students taking the revised GRE (2012 and later) must have a minimum scores of 144 in quantitative reasoning and 153 in verbal reasoning, and an analytical writing score of at least 4.0.

International students must submit TOEFL scores unless they are exempt as specified in the International Applicant Requirements section 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.

tential for advanced academic work. At minimum, one letter must be from a university faculty member

- 3. Official transcripts, or certified copies thereof, of all academic work at the college level or above
- 4. Required test scores

All applicants are required to submit Graduate Record Exam (GRE) scores with a minimum combined score of 1000 quantitative + verbal (with a minimum score of 500 in each area) and 3.0 (analytical writing). Students taking the revised GRE (2012 and later) must have a minimum scores of 144 in quantitative reasoning and 153 in verbal reasoning, and an analytical writing score of at least 4.0.

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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.

Master of Science in Technical Communication and Information Design

33 Credit hours
TCID core (15 hours)
Electives (minimum of 15 hours)
Project or thesis (minimum of 3 hours)
Project review or Thesis exam

The M.S. in Technical Communication and Information Design provides an understanding of communication practices, familiarity with information and communication technologies, and an awareness of the importance of collaboration in enhancing the flow of information throughout an organization.

Students preparing for careers as technical communicators 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 Humanities department, at least one of them from the Graduate Program in Technology and Humanities. Students may apply up to six hours of credit in one of the following courses: COM 594 (Project) or COM 591 (Thesis).

Required Courses

- ${\rm COM}~525 \ \ {\rm User} \ {\rm Experience} \ {\rm Research} \ {\rm and} \ {\rm Evaluation}$
- COM 528 Document Design
- COM 529 Technical Editing
- ${\rm COM}~530~{\rm Standards}{\rm -Based}~{\rm Web}~{\rm Design}$
- COM 543 Publication Management

Electives

${\rm COM}~428$	Verbal and Visual Communication
${\rm COM}~435$	Intercultural Communication
$\rm COM~501$	Introduction to Linguistics
$\rm COM~506$	World Englishes
$\rm COM~508$	Structure of Modern English
$\rm COM~509$	History of the English Language
$\rm COM~515$	Discourse Analysis
$\rm COM~532$	Rhetoric of Technology
$\rm COM~531$	Web Application Development
$\rm COM~535$	Instructional Design
$\rm COM~536$	Proposal and Grant Writing
$\rm COM \ 538$	Entrepreneurship in Technical
	Communication
$\rm COM~541$	Information Structure and Retrieval
COM 542	Knowledge Management
$\rm COM~545$	Writing for Academic Publication
COM 553	Globalization and Localization
$\rm COM~561$	Teaching Technical Communication
$\rm COM~571$	Persuasion
$\rm COM~577$	Communication Law and Ethics
$\rm COM~580$	Topics in Communication
$\rm COM~585$	Internship
$\rm COM~601$	Research Methods and Resources

Other courses as approved by the student's advisor and one of the co-directors of graduate studies. No more than 9 hours of 400-level courses may be counted toward the degree.

Master of Science in Information Architecture

33 Credit hours
IARC core (18 hours)
Electives (minimum of 12 hours)
Project or thesis (minimum of 3 hours)
Project or Thesis
Project review or Thesis exam

The M.S. in 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.

Students preparing for careers as technical communicators 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 Humanities department, at least one of them from the Graduate Program in Technology and Humanities. Students may apply up to six hours of credit in one of the following courses: COM 594 (Project) or COM 591 (Thesis).

Required Courses

- COM 525 User Experience Research and Evaluation
- COM 528 Document Design
- COM 530 Standards-Based Web Design
- ${\rm COM}~541~~{\rm Information}~{\rm Structure}~{\rm and}~{\rm Retrieval}$
- ${\rm COM}~542 {\rm \ Knowledge\ Management}$
- COM 543 Publication Management

Electives

COM 428	Verbal and Visual Communication
COM 430	Introduction to Web Design and Management
COM 431	Intermediate Web Design and Management
COM 432	Advanced Web Design and Management
$\rm COM~435$	Intercultural Communication
$\rm COM~501$	Introduction to Linguistics
$\rm COM~506$	World Englishes
$\rm COM~508$	Structure of Modern English
$\rm COM~509$	History of the English Language
$\rm COM~515$	Discourse Analysis
$\rm COM~531$	Web Application Development
$\rm COM~532$	Rhetoric of Technology
$\rm COM~535$	Instructional Design
${\rm COM}~536$	Proposal and Grant Writing
$\rm COM~538$	Entrepreneurship in Technical
	Communication
COM 541	Information Structure and Retrieval
COM 542	Knowledge Management
COM 545	Writing for Academic Publication
$\rm COM \ 553$	Globalization and Localization
$\rm COM~561$	Teaching Technical Communication
$\rm COM~571$	Persuasion
$\rm COM~577$	Communication Law and Ethics
$\rm COM~580$	Topics in Communication
$\rm COM~585$	Internship
COM 601	Research Methods and Resources

Other courses as approved by the student's advisor and one of the co-directors of graduate studies. No more than 9 hours of 400-level courses may be counted toward the degree.

Doctor of Philosophy in Technical Communication

84 credit hours beyond the bachelor's degree, including

- Technical communication core (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 84)

Qualifying examination Comprehensive examination Dissertation proposal Dissertation Dissertation (final thesis) examination

Transfer Units

Students who have already earned master's degrees or undertaken graduate work in relevant fields may transfer credit hours toward the doctoral degree (up to 36 credit hours for graduate coursework in relevant fields at IIT, up to 30 credit hours for graduate coursework in relevant fields at other institutions).

Required Courses (30 credit hours)

- ${\rm COM}~521~~{\rm Key}~{\rm Concepts}~{\rm in}~{\rm Technical}~{\rm Communication}$
- COM 525 User Experience Research and Evaluation
- COM 529 Technical Editing
- COM 541 Information Structure and Retrieval
- COM 542 Knowledge Management
- COM 543 Publication Management
- COM 601 Research Methods and Resources

AND one of the following:

- COM 528 Document Design
- COM 530 Standards-Based Web Design
- ${\rm COM}~535~~{\rm Instructional~Design}$

AND one of the following:

- COM 501 Introduction to Linguistics
- COM 506 World Englishes
- COM 508 Structure of Modern English
- COM 509 History of the English Language
- COM 515 Discourse Analysis

AND one of the following:

COM 602	Qualitative Research Methods
COM 603	Quantitative Research Methods

Electives (at least 15 credit hours)

COM 501	Introduction to Linguistics
COM 506	World Englishes
COM 508	Structure of Modern English
COM 509	History of the English Language
COM 515	Discourse Analysis
COM 528	Document Design
COM 530	Standards-Based Web Design
COM 531	Web Application Development
COM 532	Rhetoric of Technology
COM 535	Instructional Design
COM 536	Proposal and Grant Writing
COM 538	Entrepreneurship in Technical
	Communication
COM 545	Writing for Academic Publication
COM 553	Globalization and Localization
COM 561	Teaching Technical Communication
COM 571	Persuasion
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- COM 577 Communication Law and Ethics
- COM 580 Topics in Communication

Other courses as approved by the student's advisor and one of the co-directors of graduate studies. No more than 9 hours of 400-level courses may be counted toward the degree.

### **Dissertation Research**

COM 691 Research and Dissertation for Ph.D. degree (at least 24 credit hours)

## Additional Courses

Additional coursework or dissertation research sufficient to meet the requirement of 84 credit hours beyond the bachelor's degree. All work for a doctoral degree should be completed within six calendar years after the approval of the program of study; if it is not, then the student must re-pass the Qualifying Examination.

## Doctor of Philosophy in Technical Communication - continued

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 (1) a brief statement of research interests and (2) 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 technical communication program. Based on exam results, the committee may recommend changes to the student's Program 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 technical communication program and one from a Ph.D.-granting academic unit at IIT other than the Humanities Department. 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 advisor 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, and (6) a statement of anticipated results or outcomes. The proposal review committee consists of four Category I faculty: three from technical communication and one from a Ph.D.-granting academic unit at IIT other than the Humanities Department. 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 technical communication and one from a Ph.D.-granting academic unit at IIT other than the Humanities Department. 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 technical communication and may address areas of interaction between technical communication 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 Usability Testing and Evaluation Center or Speech Analysis Lab), pedagogical, historical, or theoretical.
# **Certificate Programs**

## **Admission Guidelines**

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

## **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). The program consists of 12 credit hours of coursework (four courses).

## **Required Courses**

COM 424Document DesignORImage: Com 528COM 528Document DesignCOM 525User Experience Research and EvaluationCOM 425EditingORImage: Com 529COM 529Technical Editing

## 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. The program consists of 15 credit hours (five required courses). passed with a grade of "B" or better may also be applied to the M.S. in Technical Communication and Information Design, the M.S. in Information Architecture, or the Ph.D. in Technical Communication (for students who are admitted to one of those programs), as long as those courses were not applied to another degree. However, no more than 9 hours of 400-level coursework may be counted toward a degree program.

## AND one of the following:

COM 428	Verbal and Visual Communication
COM 435	Intercultural Communication
COM 523	Communicating Science
COM 530	Standards-Based Web Design

## **Required Courses**

- COM 424 Document Design
- **OR** COM 528 Document Design
- COM 525 User Experience Research and Evaluation
- COM 530 Standards-Based Web Design
- COM 535 Instructional Design
- COM 542 Knowledge Management

# **Course Descriptions**

## Communication

## 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. (3-0-3)

## COM 503

#### Anal & Comm 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.

(3-0-3)

## COM 506

## World Englishes

Analysis of the variations of the English language throughout geographic and cultural regions of the world. (3-0-3)

#### 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. (3-0-3)

## 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. (3-0-3)

#### COM 510

#### The Human Voice: Description, Analysis, & Application

Analysis of human and synthetic speech intended for technology mediated environments and devices. Focs on talker characteristics that affect speech intelligibility and social factors that affect talker characteristics. Attention to design characteristics of technology mediated speech and how humans react to it.

(3-0-3)

## 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.

(3-0-3)

## COM 515

#### **Discourse Analysis**

Analysis of spoken and written texts on the intersentential and metalinguistic levels (e.g. semantic roles; givennew 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. (3-0-3)

#### COM 521

### Key Concepts in Technical Communication

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. (3-0-3)

#### 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. (3-0-3)

#### COM 525

## User Experience Research & 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. (3-0-3)

## COM 527

#### Standards-based Web Design

This course introduces the theory and practice of standardsbased web design and development. The course focuses on an agile, incremental approach to building accessible, usable, and sustainable web pages that work across all modern browsers and web-enables mobile devices. The course also provides a rhetorical and technological foundation for quickly establishing competencies in other areas of digital communication, such as web application development. (3-0-3)

## 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.

(3-0-3)

#### 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. (3-0-3)

#### **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. (3-0-3)

## 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)] (3-0-3)

## COM 532

## Rhetoric of Technology

A course that explores the theoretical and applied intersections of the rhetorical tradition and digital communication technologies. (3-0-3)

# 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. (3-0-3)

# COM 536

## **Proposal & 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. (3-0-3)

## **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. (3-0-3)

#### COM 541

#### Information Structure & Retrieval

An examination of conceptual foundations and applied uses of structured languages and databases for structuring information with an emphasis on approaches to singlesourcing materials for presentation in digital and print formats.

(3-0-3)

## 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. (3-0-3)

## COM 543

## **Publication Management**

Intensive work developing and using systems to create and deliver content digitally and in print. Special emphasis on project management and large-team collaboration. Formerly known as COM 537.

Prerequisite(s): [(COM 530*) OR (COM 541*) OR (COM  $542^*$ )] An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

#### **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. (3-0-3)

#### COM 553

#### **Globalization & 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.

(3-0-3)

# 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.

(3-0-3)

# COM 571

## Persuasion

The study of covert and overt persuasion and their influences on society and individuals. (3-0-3)

## 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. (3-0-3)

## COM 577

#### **Communication Law & 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. (3-0-3)

#### COM 580

#### **Topics in Communication**

An investigation into a topic of current interest in communication, which will be announced by the instructor when the course is scheduled. (3-0-3)

# COM 583

## Social Networks

This course will discuss a variety of measures and properties of networks, identify various types of social networkds, describe how position within and the structure of networks matter, use software tools to analyze social network data, and apply social network analysis to areas such as information retrieval, social media, and organizational behavior. (3-0-3)

COM 584

#### Humanizing Technology

This course will investigate and experiment with both conceptual and applied efforts to humanize technology, especially computer technology. We will question the goals of humanization and its relationships to concepts such as design ethics and user-centered and emotional desigh. While the ficus of the class will be on computer technology and programming languages, we will also look at humanization with regard to industrial design, enginereing, architecture, and nanotechnologies.

# (3-0-3)

#### 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 & 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 & 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. (3-0-3)

#### 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)]

(3-0-3)

#### COM 603

#### **Quantitative Research Methods**

This course is for doctoral students of technical communication who have a command of general research methods but who require a deeper understanding of methods for the collection and analysis of quantitative data. Prerequisite(s): [(COM 601)]

(3-0-3)

## 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)

# History

# **HIST 507**

## **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)

## Humanities

## **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.

# (0-0-0)

## Philosophy

## **PHIL 551**

#### Science & 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? (3-0-3)

## **PHIL 560**

#### Ethics

A study of the fundamental issues of moral philosophy. (3-0-3)

#### PHIL 570 Engineering Ethics

A study of moral and social responsibility for the engineering profession including such topics as safety, confidentiality, and government regulation.

(3-0-3)

## 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. (3-0-3)

## 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. (3-0-3)

#### **PHIL 574**

## Ethics in Computer Science

Moral problems that confront professionals in computerrelated 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.

(3-0-3)

# 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. (3-0-3)

#### **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)

## Undergraduate Courses Available to Graduate Students

Note: Students may take up to an approved number of the following courses.

## AAH 491

Independent Reading and Research

COM 401 Advanced Composition and Prose Analysis

COM 421 Technical Communication

COM 423 Communication in the Workplace

COM 424 Document Design

COM 425 Editing

COM 428 Verbal and Visual Communication

COM 430 Introduction to Web Design and Management

COM 431 Intermediate Web Design and Management

COM 432 Advanced Web Design and Management

COM 435 Intercultural Communication

COM 437 Video Documentation

COM 438 Technical Exhibit Desisgn

COM 440 Introduction to Journalism

HIST 491 Independent Reading and Research

PHIL 491 Independent Study

# Industrial Technology and Management

Suite 4001 South 3424 S. State Street Chicago, IL 60616 312.567.3650 312.567.3655 fax www.iit.edu/cpd/intm

**Director:** Mazin Safar

The Master of Industrial Technology and Operations (M.I.T.O.) is a professional degree designed for individuals who plan to make a career in industry. The purpose

of the M.I.T.O. program is to enhance the ability of the 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 M.I.T.O. curriculum prepares students to move into management, supervisory and staff positions in industry. The M.I.T.O. is considered to be a "hybrid" degree, blending practical application of current technologies with the management skills needed to oversee a wide range of industrial operations. Students build a program of study suited to their career interests and experience. The M.I.T.O. is not a MBA or an engineering degree, therefore it is not recommended for those planning to pursue careers in academia or research.

# **Degree Offered**

Master of Industrial Technology and Operations

## **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 IIT. 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 900 for the verbal and quantitative portions of the exam taken prior to July 2011, or a combined score of 292 for exams taken August 2011 and after. Applicants from countries where English is not the primary language also must complete the TOEFL with a minimum score of 70 on the Internet-based test (equivalent to 523 PBT) with no individual section scored below 15. IELTS scores are also accepted, with a minimum score of 5.5. Students with a TOEFL score between 70 and 89 or an IELTS score between 5.5. and 6.0 will be required to complete a remedial English course during the first term at IIT.

All applicants must submit a completed application form, the application fee, official transcripts (or certified copies) for all academic work at the college level, two letters of recommendation, 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 M.I.T.O. degree. These individuals are often technical experts who, once employed in industry, have found that they lack an understanding of industrial operations, applied technologies, and management skills. As a hybrid program covering both technology and management, the M.I.T.O. curriculum enables such specialists to move from technology into operations.

# Faculty

Maurer, William, Industry Associate Professor and Coordinator of Outreach Activities. B.S., University of Illinois; M.S., Keller Graduate School of Management. Safar, Mazin, Industry Professor and Director. B.S., Al-Hikma University (Iraq); M.S., Illinois Institute of Technology; M.B.A., University of Chicago.

## **Adjunct Faculty**

Arditi, David, Professor of Civil and Architectural Engineering. B.S., M.S., Middle East Technical University (Turkey); Ph.D., Loughborough University of Technology (United Kingdom). Construction engineering and management.

Ayman, Roya, Professor of Psychology and Division Head of Industrial, Organizational, and Business Psychology. B.A., M.A., Ph.D., University of Utah. Leadership, diversity, organizational climate, and workfamily interface.

Blair, Jack, M.B.A., University of St. Thomas (Minnesota). Supply chain management, logistics optimization, six sigma quality, material handling.

Bobco, William, Adjunct Professor. B.S., M.B.A., University of Chicago. Production management, supply chain management.

Caltagirone, John, Adjunct Professor. B.B.A., Loyola University. Supply chain management and logistics.

Cesarone, John, Senior Lecturer of Mechanical Engineering. B.S., M.S., University of Illinois; Ph.D., Northwestern University. Robotics, reliability engineering and manufacturing.

Coates, James, Adjunct Professor. A.S., Triton College. Heating, ventilation and cooling systems technology.

Davis, Blake, Adjunct Professor. B.A., M.A., Illinois Institute of Technology. City and regional planning.

Donahue, John, Adjunct Professor. J.D., John Marshall Law School; Ed.D., Roosevelt University. Human resource management.

Field, Jerry, Adjunct Professor. B.S., M.B.A., Roosevelt University; Ed.D. Loyola University (Chicago). Marketing, economics, curriculum instruction, adult instruction management.

Footlik, Robert B., PE, Adjunct Professor. B.S., Illinois Institute of Technology. Industrial engineering, warehousing operations, logistics and distribution technologies.

Goldberg, Joel, Adjunct Professor. B.Ed , Northeastern Illinois University.. Training, manufacturing processes, industrial management.

Gopal, Gurram, Adjunct Professor. B.Tech., Indian Institute of Technology (India); M.S., Ph.D., Northwestern University. Chemical Engineering, industrial engineering, operations research, economics, finance. Hoffman, Robert, Adjunct Professor. Oxford and London School of Economics. Transportation, Logistics, and Economics.

Jain, Jagjit, Adjunct Professor. B. Tech in Mechanical Engineering, MS in Operations Research, MBA in Finance/Economics/Accounting. .

Jabbari, Kamyar, B.S., Towson State; M.B.A., University of Chicago; J.D., IIT Chicago-Kent College of Law. Corporate finance, international finance, economics, and banking law.

Kumiega, Andrew, Adjunct Professor. B.S., University of Illinois (Chicago); M.S. , Illinois Institute of Technology; M.S., Ph.D., University of Illinois (Chicago). Engineering management, industrial engineering, finance.

Lemming, Raymond, Adjunct Professor. B.S. in Civil Engineering, B.S. in Psychology, M.B.A. in Organizations and Management, Juris Doctor.

Lewis, Philip, Adjunct Professor. B.S., Milwaukee School of Engineering. Industrial management, manufacturing processes.

Prendergast, John, Adjunct Professor. B.A. in Occupational Education; M.A. in Education.

Rozansky, Irene, Adjunct Professor. B.A., Purdue University; M.B.A., University of Massachusetts. Industrial risk assessment and management.

Shankar, Rama, Adjunct Professor. B.S., Mechanical Engineering; M.S., Materials Management; M.S., Engineering Management. Quality control, industrial management and operations, six sigma.

Shields, Herb, Adjunct Professor. B.S., Clarkson University. Electrical engineering, logistics, purchasing and acquisitions.

Tijunelis, Donatas, PE, Adjunct Professor. B.S., M.S. in Chemical Engineering, D.B.A.. Operations management, strategic project management, energy and sustainability.

Tomal, Daniel, Adjunct Professor. B.S., M.S., Ph.D., Bowling Green State University. Electrical technology, industrial technology, administration and supervision.

Twombly, John R., Clinical Professor of Accounting and Finance and Director of Undergraduate Programs. B.S., University of Pennsylvania; M.B.A., Ph.D., University of Chicago; Certified Public Accountant. Financial and managerial accounting.

# Master of Industrial Technology and Operations

Each student's program of study is customized to best serve individual career objectives. Of the 30 credit hours required for the M.I.T.O. 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 M.I.T.O. degree. A maximum of 6 credit hours may be applied from special project courses (INTM 597 or an Interprofessional Project (IPRO 497)). A total of 9 credit hours taken at a different university (passed with the grade of "B" or better) may be transferred to IIT and applied towards the M.I.T.O. 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 M.I.T.O. program allows students to complete an industrial specialization, or simply take the 10 courses of greatest interest. A

## Master of Industrial Technology and Operations

30 credit hours

## **Required Credit Hours**

Elective courses 18-30 hours Special project 0-6 hours Optional specialization courses 12 hours

## **Elective Courses**

INTM 502	Fundamentals of Industrial Engineering
INTM 507	Construction Technology
INTM 508	Cost Management
INTM 509	Inventory Control
INTM 511	Industrial Leadership
INTM 514	Topics in Industry
INTM 515	Advanced Project Management
INTM 518	Industrial Risk Management
INTM 520	Applied Strategies for the Competitive
	Enterprise
INTM $522$	Computers in Industry
INTM 530	Transportation
INTM 521	Manufacturing Processes for Motals and

INTM 531 Manufacturing Processes for Metals and Mechanical Systems specialization requires the completion of 12 credit hours (4 courses) in any one of four concentrations within the INTM curriculum: Industrial Facilities (IF), Industrial Sustainability (ST), Manufacturing Technology (MT), or Supply Chain Management (SCM). Alternatively, students may complete up to 4 courses in another IIT department with appropriate qualifications and approvals. For example, students have taken courses from Stuart School of Business, Armour College of Engineering, and the Food Safety and Technology Program.

INTM courses are presented live and via interactive video at IIT's Main Campus in Chicago and Rice Campus in Wheaton IL. In addition, the M.I.T.O. program can be completed entirely over the Internet. 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. A demonstration of IIT web-based courses is available at http://iit.edu/iit_online/.

INTM $532$	Manufacturing Processes for Electronics and
	Electrical Systems
INTM $533$	Manufacturing Processes in Chemical
	Industries
INTM $540$	Supply Chain Management
INTM $542$	Warehousing and Distribution
INTM $543$	Purchasing
INTM $544$	Export/Import
INTM $545$	Strategic International Business
INTM $546$	Manufacturing and Logistics Information
	Systems
INTM $559$	Issues in Industrial Sustainability
INTM $560$	Sustainability of Critical Materials
INTM $561$	Energy Options for Industry
INTM $562$	Special Topics in Sustainability

Up to 12 elective credits of 400-level INTM courses may be completed

Up to 12 elective credits of 400- or 500-level courses from a different academic discipline may be completed, with advisor and instructor approval.

## **Specialization Courses**

An industrial specialization requires completion of four courses within an identified subject area.

## Industrial Facilities (IF)

- INTM 413 Facilities and Construction Administration
- INTM 417 Construction Estimating
- INTM 507 Construction Technology
- INTM 515 Advanced Project Management

## Supply Chain Management (SCM)

- INTM 509 Inventory Control
- INTM 530 Transportation
- INTM 540 Supply Chain Management
- INTM 542 Warehousing and Distribution
- INTM 543 Purchasing
- INTM 544 Export/Import
- INTM 546 Manufacturing and Logistics Information Systems

## Manufacturing Technology (MT)

INTM $406$	Quality Control
INTM $531$	Manufacturing Processes for Metals and
	Mechanical Systems
INTM $532$	Manufacturing Processes for Electronics and
	Electrical Systems
INTM $533$	Manufacturing Processes in Chemical
	Industries
INTM $546$	Manufacturing and Logistics Information
	Systems

#### Industrial Sustainability

- INTM 559 Issues in Industrial Sustainability
- INTM 560 Sustainability of Critical Materials
- INTM 561 Energy Options for Industry
- INTM 562 Special Topics in Sustainability

# **Course Descriptions**

Numbers in parentheses indicate class, lab and total credit hours, respectively.

#### **INTM 502**

#### **Fundamentals of Industrial Engineering**

Industrial engineering concepts are introduced and the student prepared to perform basic engineering tasks, including design of workstations, cells and lines. Coverage includes time and motion studies, work measurement, ergonomics, route sheets, plant layout, site selection, equipment selection, MRP, JIT, etc. Scheduling techniques will be covered along with material control techniques. Management Information Systems (MIS) are introduced and options covered. (3-0-3)

#### 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. (3-0-3)

## INTM 508

## Cost Management

Accounting basics are introduced with primary emphasis on the costing and estimating procedures as used in industry. The objective of this course is to provide a good understanding of financial activities and hands-on experience in working with a variety of costing and accounting systems. (3-0-3)

#### **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.

(3-0-3)

#### 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. (3-0-3)

## INTM 514

#### **Topics in Industry**

This course provides overview of multiple industrial sectors and the influences that are forcing change. All aspects of industry are considered: history of industry, inventory, supply chain, e-commerce, management, manufacturing, industrial facilities, resource management, electronics and chemical industries, alternate energies, marketing, entrepreneurship, computers as tools, and other specialty areas. (3-0-3)

## 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. (3-0-3)

## 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.

# (3-0-3)

# 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. (3-0-3)

#### (0-0-0)

## INTM 522

## **Computers in Industry**

Computers are ubiquitous in all industrial sectors. Management Information Systems (MIS) are available for even the most complex of industrial operations. The integration of MIS with operational specialties (such as order entry, production scheduling, quality control, shipping and invoicing) is discussed. A variety of Microsoft Excel tools are introduced and utilized to set up approaches for handling a variety of industrial situations. (3-0-3)

#### INTM 530 Transportation

#### 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.

(3-0-3)

## INTM 531

#### Manufacturing Processes for Metals & Mechanical Systems

A broad range of manufacturing processes are studied, including casting, forging, rolling, sheet metal processing, machining, joining, and non-traditional methods such as powder, EDM, and additive processes. Particular attention on interrelationships between manufacturing processes and properties developed in the work place, both intended and unintended. Economic considerations and tradeoffs, as well as computer-integrated manufacturing topics, are also explored. (3-0-3)

#### **INTM 532**

Manufacturing Processes for Electronics & Electrical Systems The materials used in Electronic and Electrical (E&E) manufacturing will be reviewed including materials and components that are used to produce chips, PCBs, and wiring systems. Focus will be on the processes for producing the range of parts and products included in this broad sector. Automation for producing parts and assemblies will be covered. Techniques covered will include surface mounted technology (SMT), wave soldering, automation insertion, automated inspection, etc. The industrial structure that makes up this sector of manufacturing will be covered. (3-0-3)

#### **INTM 533**

#### Manufacturing Processes in Chemical Industries

This course provides a survey overview of the many chemical manufacturing processes found in the energy, food, drug, and synthetic polymer sectors. Related societal, environmental, and regulatory impacts are discussed such as sustainability, OSHA, and EPA. Implications for recovery and reuse as well as new non-polluting processes are explored. The overall industrial structure that makes up this sector of manufacturing will be covered.

(3-0-3)

#### **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. (3-0-3)

#### **INTM 542**

#### Warehousing & 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.

(3-0-3)

## 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.

(3-0-3)

# 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.

(3-0-3)

#### **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.

# (3-0-3)

## INTM 546

#### Manufacturing & Logistics Information Systems

This course provides an overview of manufacturing and supply chain information systems, tools, and techniques utilized for effective decision making. Current state-of-the-art and commercially available industrial software packages, such as MRP, WMS, TMS, APS, etc., will be used and their impact on management decision making analyzed. (3-0-3)

#### 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. (3-0-3)

## **INTM 560**

## Sustainability of Critical Materials

This course explores the limitations in supply and the need for sustainable use of carbon and non-carbon-based materials such as oil, minerals, food, water, and other natural resources used by industry. Limitations in the global availability of such resources pose challenges to industry which will require careful consideration and planning to ensure continued prosperity for current and future generations. Course will cover strategies and options to mitigate anticipated shortages and optimize the use of non-renewable natural resources, review of fuel and raw material pricing, and cost/benefit analysis of sustainable development proposals. Technical analyses will be presented during class discussions, but a technical background is not required. (3-0-3)

## **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. (3-0-3)

## **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. (0-0-3)

## **INTM 594**

**Special Projects** Special project.

(Credit: Variable)

#### **INTM 597 Special Projects**

Independent study and project. Permission of instructor required.

(Credit: Variable)

# Information Technology and Management

IIT School of Applied Technology

Daniel F. and Ada L. Rice Campus 201 E. Loop Road Wheaton, IL 60187 www.iit.edu/applied_tech/

Dean and Program Director:

C. Robert Carlson 630.682.6002 carlson@iit.edu The mission of the Master of Information Technology & Management program is to educate and inform students to prepare them to assume technical and managerial leadership in the information technology and cyber security fields. The Information Technology and Management program applies 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 taken from the IIT Chicago-Kent College of Law curriculum to give cyber security and forensics practitioners a thorough grounding in legal issues and compliance. The program provides an innovative experience where students work on cutting-edge, industrysponsored 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 MITM degree on-line.

# **Degrees Offered**

Master of Information Technology & Management

# **Certificate Programs**

Advanced Software Development Cyber Security Management Cyber Security Technologies Data Center Operations and Management Data Management and Analytics Digital Voice and Data Communication Technologies Master of Cyber Forensics and Security

Information Technology Innovation, Leadership and Entrepreneurship Information Security Management Systems Analysis System Administration Web Design and Application Development

# Faculty

Carlson, C. Robert, Professor of Computer Science in the School of Applied Technology, Dean of the School of Applied Technology, Director of the Rice Campus, and Academic Director of Information Technology and Management. B.A., Augustana College; M.S., Ph.D., University of Iowa. Information architecture, object-oriented modeling and design, software maturity models, database design, software engineering, and IT entrepreneurship.

Davids, Carol, Industry Professor and Director, School of Applied Technology Real-Time Communications Laboratory. B.S.E.E. Cornell University; M.I.T.M. Illinois Institute of Technology. Voice over IP, voice and data networks, and digital and voice communications.

Hajek, Jeremy, Industry Associate Professor. B.I.T.M., M.I.T.M., Illinois Institute of Technology. Cloud computing, systems architecture, enterprise computing, embedded systems, and operating systems. Hendry, Robert, Industry Professor. B.S., Aurora University; M.S., University of Maryland. Data management, databases, data analytics, data warehousing, application development, and informatics.

Lidinsky, William, Industry Professor and Director, School of Applied Technology Security and Forensics Laboratory. B.S.E.E., M.S.E.E. Illinois Institute of Technology; M.B.A. University of Chicago. Computer networking, computer and network security, computer and network forensics, vulnerability testing, and steganography.

Trygstad, Raymond E., Industry Professor, Associate Director for Information Technology and Management, and Director of Information Technology for the School of Applied Technology. B.S., United States Naval Academy; M.S.S.M., University of Denver. System administration, operating system virtualization, information security management, information technology policy, cloud computing, open source operating systems and applications, and multimedia.

# Laboratories and Research Centers

The IIT School of Applied Technology operates and administers over 200 computers and servers at the Main and Rice Campuses, to support teaching, learning, and research. Nine laboratories include Sun Solaris facilities, a networking/network security and computer forensics facility, a dedicated Voice over IP (VoIP) facility, which includes an entire CISCO VoIP LAN as well as video and mesh wireless capabilities, and the world's first 10GBASE-T 10-gigabit Ethernet academic computing facility. The security/forensics, VoIP, and 10GBASE-T laboratories provide additional facilities for student

# **Admission Requirements**

Applicants for admission must have earned a four-year bachelor's degree from an accredited institution with a minimum cumulative undergraduate GPA of 3.0/4.0. International applicants are required to submit a GRE score with a minimum score of 1200 (combined score for tests taken prior to Oct. 1, 2002) or 900 quantitative + verbal and 2.5 analytical writing (for tests taken on or after Oct. 1, 2002) or 300 quantitative + verbal and 2.5 analytical writing (for tests taken on or after August 1, 2011), and may be required to submit a TOEFL score (see requirements within this bulletin). Admission as a non-degree student follows the university policy set forth in this bulletin.

Students whose undergraduate degree is not in a computer-related area or who do not have significant experience or certifications in the information technology field will be required to demonstrate proficiency in the 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 IIT. projects and applied research, some of which is undertaken in conjunction with industry partners. All laboratories are normally available for student use outside of class hours, and one or more laboratories are available for student use weekdays between 10 am and 10 pm 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.

Current prerequisites for the Master of Information Technology & Management include computer hardware and operating system literacy (ITM 301 or ITM 302 or equivalent coursework, certification, or experience) and an ability to program at a basic level using a contemporary programming language (ITM 311 or ITM 312 or equivalent coursework, certification, or experience). Students enrolled in undergraduate post-baccalaureate studies (see information at the front of this bulletin) 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 (ITMO 301 or ITMO 302 or equivalent coursework certification or experience); an ability to program at a competent level using a contemporary programming language (ITMD 411); basic knowledge of networking concepts, protocols, methods, and the Internet (ITMO 440), and the ability to create and administer databases using a modern database management system (ITMD 421). Students enrolled in undergraduate postbaccalaureate studies may take these courses as part of that program.

# **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 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. The 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 very low scores on the GRE Verbal (generally 10th percentile or lower) may be required to complete the IIT English Proficiency Review (EPR) Essay Examination or an English evaluation. If students cannot pass this examination or evaluation, they will be required to enroll in an appropriate ENG or PESL course and demonstrate proficiency at course completion.

# Master of Information Technology & Management

30 credit hours (Courses may be selected from 400-and 500-level courses; a minimum of 18 credit hours must be at the 500-level or higher.)

GPA of  $3.0/4.0~{\rm or}$  better

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 complete core courses or demonstrate their knowledge through equivalent coursework, certification, or experience. These core courses will ensure an ability to program at a competent level using a contemporary programming language (ITMD 411); basic knowledge of networking concepts, protocols, and methods (ITMO 540); knowledge of the Internet, including the ability to build Web sites and deliver them on a server (ITMD 461); the ability to create and administer databases using a modern database management

# Core Courses (9 hours)

## **Required Courses**

ITMD 411 Intermediate Software Development

## AND 6 hours from the following:

- ITMD 421 Data Modeling and Applications
- ITMD 461  $\,$  Internet Technologies and Web Design
- ITMD 540 Introduction to Data Networks and the Internet
- ITMO 456 Introduction to Open Source Operating Systems

# Computer and Information Security (21 hours)

## Recommended Courses (12 hours)

- ITMO 456 Introduction to Open Source Operating Systems
- ITMS 548 Cyber Security Technologies
- ITMS 549 Cyber Security Technologies: Projects and Advanced Methods
- ITMS 578 Cyber Security Management

## system (ITMD 421); and knowledge of a contemporary operating system (ITMO 456). Students enrolled in undergraduate post-baccalaureate studies (see information in this bulletin) may take these courses as part of that program, but they will not then be applied to their graduate degree.

The following course groupings 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 advisor. Final determination of completion of a specialization will be made by a student's graduate advisor. Students are not required to choose a specialization for degree completion and can mix courses from different specializations; a general program of study is also available.

Notes: Core courses may be waived upon presentation of evidence of equivalent coursework, certification, or experience or successful completion of the placement examination. Approval of waivers will be made by the student's advisor or the ITM Associate Director. If any one core course is waived, students must still complete nine hours of core course content. Core courses that also apply to specializations will still fulfill the core course requirement.

# AND 6 hours from the following:

Any 500-level ITMS elective (ITMS 579 may only be taken once as part of this requirement).

## AND 3 or more hours from the following:

Any 500 level ITMS elective

ITMO 551 Distributed Workstation System Administration

# OR

ITMO 552Client-Server System AdministrationITMM 586Information Technology Auditing

# Voice and Data Communication Technology (21 hours)

Recommended Courses (12 hours)		ITMM $575$	Networking and Telecommunications
ITMO 456	Introduction to Open Source Operating		Management
	Systems	ITMO $541$	Network Administration and Operations
ITMO 540	Introduction to Data Networks and the	ITMO $542$	Wireless Technologies and Applications
	Internet	ITMO $544$	Cloud Computing Technologies
$\rm ITMO~545$	Telecommunications Technology	ITMO $547$	Voice Communications Over Data Networks:
$\rm ITMO~546$	Voice Communications Over Data Networks		Projects & Advanced Methods
		ITMO $555$	Intelligent Device Applications
AND 9 hours from the following:		ITMS $543$	Vulnerability Analysis and Control
ITMD $565$	Rich Internet Applications	ITMS $548$	Cyber Security Technologies
ITMM $571$	Project Management for Information	ITMS $549$	Cyber Security Technologies: Projects &
	Technology Management		Advanced Methods
IT Manag	ement and Entrepreneurship (18 hours)		
Recommen	ded Courses (9 hours)	ITMM 582	Business Innovation

Recommended Courses (5 nours)	11101002	Dusiness innovation
ITMM 571 Project Management for Information	ITMS $578$	Information Systems Security Management
Technology Management	ITMT $531$	Object Oriented System Analysis, Modeling
ITMM 574 Information Technology Management		and Design
Frameworks	INTM $511$	Industrial Leadership
ITMM 581 IT Entrepreneurship	INTM $515$	Advanced Project Management
AND 0 hours from the following	INTM $522$	Computers in Industry
And 9 hours from the following:	INTM $534$	Resource Management
IT ID 522 UNI D 10 ft D 1	INTM $543$	Purchasing
TTMD 532 UML Based Software Development	<b>TECH 581</b>	Consulting for Technical Professionals
ITMM 570 Fundamentals of Management for Technical		5

Data Management (18 hours)

Professionals

	,		
Recommended Courses (9 hours)		ITMD $527$	Data Analytics
ITMD 421	Data Modeling and Applications	ITMD $529$	Advanced Data Analytics
ITMD $422$	Advanced Database Management	ITMM $574$	Information Technology Management
ITMD 528	Database Security		Frameworks
	2 alabase security	ITMO $557$	Storage Technologies
AND 9 hou	rs from the following:	ITMS $578$	Cyber Security Management
ITMD 521	Client Server Technologies and Applications	ITMT $531$	Object Oriented System Analysis,
ITMD $526$	Data Warehousing		Modeling and Design

# Web Design and Application Development (18 hours)

Recommended Courses (9 hours)	ITMD $555$	Intelligent Device Applications
ITMD 461Internet Technologies & Web DesignITMD 534Human/Computer InteractionITMD 562Web Application Development	ITMD 563 ITMD 564 ITMD 565 ITMD 566	Intermediate Web Application Development Advanced Web Application Development Rich Internet Applications Service-Oriented Architectures
AND 9 hours from the following:	ITMD $569$	Topics in Application Development
ITMD 513Open-Source ProgrammingITMD 515Advanced Software DevelopmentITMD 519Topics in Software Development	ITMM 571 ITMO 541 COM 525	Project Management for Information Technology Management Network Administration and Operations Research and Usability Testing

ITMD 532 UML Based Software Development

## Systems Analysis (18 hours)

## **Recommended Courses (9 hours)**

ITMM 571	Project Management for Information	ITMD $534$	Human Computer Interaction
	Technology	ITMD $536$	Software Testing and Maintenance
ITMM 572	Process Engineering for Information	ITMM $574$	Information Technology Management
	Technology Managers		Frameworks
ITMT 531	Object Oriented System Analysis Modeling	ITMM $575$	Networking and Telecommunications
111011 001	and Design		Management
		ITMM $586$	Information Technology Auditing
AND 9 hou	rs from the following:	ITMS $578$	Cyber Security Management
		INTM $522$	Computers in Industry
TTMD 511	Application Development Methodologies	<b>TECH 581</b>	Consulting for Technical Professionals

## Data Center Operations and Management (21 hours)

## **Recommended Courses (9 hours)**

- ITMT 535 Data Center Architecture
- ITMO 540 Introduction to Data Networks and the Internet
  ITMO 554 Operating System Virtualization
  ITMM 576 Data Center Management

## AND 6 hours from the following:

- ITMD 526 Data Warehousing
- ITMM 574 Information Technology Management Frameworks

## Software Development (18 hours)

## Recommended Courses (9 hours)

ITMD 515Advanced Software DevelopmentITMD 532UML Based Software DevelopmentITMM 571Project Management for Information<br/>Technology Management

## AND 9 hours from the following:

ITMD 412	Advanced Software Development
ITMD 511	Application Development Methodologies
ITMD 513	Open Source Programming

## System Administration (18 hours)

## **Recommended Courses (9 hours)**

- ITMO 541 Network Administration and Operations ITMO 551 Distributed Workstation System Administration
- OR
- ITMO 552 Client-Server System Administration

## AND 9 hours from the following:

- ITMM 571 Project Management for Information Technology Management
- ITMM 574 Information Technology Management Frameworks

ITMO $527$	Data Analytics
ITMO $529$	Advanced Data Analytics
ITMO $544$	Cloud Computing Technologies
ITMO $546$	Voice Communications Over Data Networks
ITMO $557$	Storage Technologies
ITMS $548$	Cyber Security Technologies
ITMS $578$	Cyber Security Management
ITMS $588$	Incident Response, Disaster Recovery and
	Business Continuity

- ITMD 519 Topics in Software Development
  ITMD 521 Client Server Technologies and Applications
  ITMD 534 Human Computer Interaction
  ITMD 536 Software Testing and Maintenance
  ITMM 572 Process Engineering for Information Technology Managers
  ITMO 555 Intelligent Device Applications
  ITMS 518 Coding Security
  ITMT 531 Object Oriented System Analysis, Modeling and Design
- ITMM 575Networking and Telecommunications<br/>ManagementITMO 456Introduction to Open Source Operating<br/>SystemsITMO 544Cloud Computing TechnologiesITMO 554Distributed Workstation System<br/>AdministrationORITMO 552ITMO 554Client-Server System Administration<br/>Operating System VirtualizationITMO 555Storage Technologies
- ITMS 558 Operating System Security

## Management Information Systems (18 hours)

# **Recommended Courses (9 hours)**

AND 9 hours from the following:	
	Technology
ITMM 571	Project Management for Information
ITMD $422$	Advanced Database Management I
ITMD $421$	Data Modeling and Applications

ITMD $526$	Data Warehousing
ITMD 527	Data Analytics
ITMD $528$	Database Security
ITMD 529	Advanced Data Analytics
ITMD 532	UML Based Software Development

## Digital Systems Technology (18 hours)

## **Recommended Courses (9 hours)**

ITMO 555 Intelligent Device Applications

- ITMT 533 Operating System Design Implementation
- ITMT 593 Embedded Systems

## AND 9 hours from the following:

- ITMD 511 Application Development Methodologies
- ITMO 540 Introduction to Data Networks and the Internet

ITMM 572	Process Engineering for Information
	Technology Managers
ITMM $574$	Information Technology Management
	Frameworks
ITMM $586$	Information Technology Auditing
ITMO $544$	Cloud Computing Technologies
ITMO $554$	Operating System Virtualization
ITMT $531$	Object Oriented System Analysis, Modeling
	and Design
INTM $515$	Advanced Project Management
INTM $522$	Computers in Industry
TECH $581$	Consulting for Technical Professionals

- ITMO 541 Network Administration and Operations
- ITMO 542 Wireless Technologies and Applications
- ITMO 544 Cloud Computing Technologies
- ITMO 545 Telecommunications Technology
- ITMO 546 Voice Communications Over Data Networks
- ITMS 556 Intelligent Device Project
- INTM 522 Computers in Industry

# Master of Information Technology & Management: General Course of Study

These are selected groupings of courses allowing students enrolled in the Master of Information Technology & Management degree to develop a broad overview knowledge of information technology. Suggested courses in each area are marked with an asterisk (*) with one alternative course listed for each area; more alternatives may be possible at the discretion of the student's advisor.

## Web Design and Application Development

*ITMD 461 Internet Technologies & Web Design ITMD 562 Web Site Application Development ITMD 565 Rich Internet Applications

## Data Management

- *ITMD 421 Data Modeling and Applications
- *ITMD 531 Object Oriented System Analysis, Modeling and Design
- ITMD 521 Client Server Technologies and Applications

## Information Technology Management

*ITMM 571	Project Management for Information
	Technology
ITMM 574	Information Technology Management
	Frameworks
ITMM 586	Information Technology Auditing

# Master of Cyber Forensics and Security

30 credit hours (Courses may be selected from 400- and 500-level courses: a minimum of 18 credit hours must be at the 500-level or higher. Law courses count as 500-level courses toward this total). GPA: 3.0/4.0

## Core Courses (15 hours) Required Courses

ITMS	538	Cyber	Forensics
------	-----	-------	-----------

- ITMS 543 Vulnerability Analysis and Control
- ITMS 548 Cyber Security Technologies
- ITMS 548 Cyber Security Technologies: Projects and Advanced Methods
- ITMS 578 Cyber Security Management
- LAW 273 Evidence

Note: 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 advisor or the ITM Associate Director.

## Networking and Communications

*ITMO 540	Introduction to Data Networks and the
*ITMS 548	Internet Cyber Security Technologies
ITMO 541	Network Administration and Operations

## Systems Administration

*ITMO 551 Distributed Workstation System Administration

OR

*ITMO 552 Client-Server System Administration

## Software Development

*ITMD 411 Intermediate Object Oriented Programming

ITMD 532 UML Based Software Development Computer & Information Security

## **Computer & Information Security**

*ITMS 578 Cyber Security Management ITMS 528 Database Security ITMS 548 Cyber Security Technologies

## Elective Courses (15 hours)

Select at least twelve hours from the following:

- ITMS 518 Coding Security
- ITMS 528 Database Security
- ITMS 539 Steganography
- ITMS 549 Cyber Security Technologies: Projects and Advanced Methods
- ITMS 555 Mobile Device Forensics
- ITMS 558 Operating System Forensics
- ITMS 579 Topics in Information Security
- ITMS 588 Incident Response, Disaster Recovery, and Business Continuity
- ITMM 585 Legal and Ethical Issues in Information Technology
- ${\rm ITMM}~586~~{\rm Information}~{\rm Technolgoy}~{\rm Auditing}$
- ITMO 456 Introduction to Open Source Operating Systems
- ITMT 594 Special Projects in Information Technology

## AND at least 3 hours from the following:

- LAW 240 National Security Law
- LAW 478 Computer and Network Privacy and Security: Ethical, Legal, and Technical Considerations
- LAW 495 Electronic Discovery

# **Certificate Programs**

Certificate programs offer working professionals an opportunity to increase their knowledge and skills in the specific areas of information technology. A certificate representing proven academic performance is presented after the required coursework is completed with a GPA of 3.0/4.0. All courses may be later applied toward the Master of Information Technology and Management degree or the Masterof Cyber Forensics and Security degree

## Advanced Software Development Certificate

This program is designed for students seeking knowledge that will enhance their skills as a software developer.

## **Required Courses**

ITMD 515 Advanced Software Development ITMM 571 Project Management for Information Technology Management for those who apply and are accepted to the degree program. Applicants should have a bachelors degree from an accredited college or university; the degree need not be in an information technology or computer related field. Prerequisites may be required for some courses in certificates; these prerequisites will not be applied to the certificate.

## AND two of the following:

ITMD 511	Application Development Methodologies
ITMD 513	Open Source Programming
ITMD 519	Topics in Software Development
ITMD 532	UML Based Software Development
ITMD 534	Human Computer Interaction
ITMD 536	Software Testing and Maintenance
ITMO 555	Intelligent Device Applications
ITMO 556	Intelligent Device Projects
ITMS $518$	Coding Security
	9 1

Students who have already completed coursework, training, or certification equivalent to ITMM 571 may substitute a fourth course from the above list.

## Cyber Security Management Certificate

This program is designed for students seeking knowledge that will prepare them for careers in the management of information security.

## **Required Courses**

ITMS 548Cyber Security TechnologiesITMS 578Information System Security Management

## Cyber Security Technologies 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.

## **Required Courses**

ITMO 543Vulnerability Analysis and ControlITMS 548Cyber Security Technologies

#### AND two of the following:

TTIME FOR	
TTMM 586	Information Technology Auditing
ITMS $543$	Vulnerability Analysis and Control
ITMS $579$	Topics in Information Security (may be
	applied to this certificate twice.)
ITMS $588$	Incident Response, Disaster Recovery and
	Business Continuity

## AND two of the following:

ITMS $518$	Coding Security
ITMS $528$	Database Security
ITMS $538$	Cyber Forensics
ITMS $539$	Steganography
ITMS $549$	Cyber Security Technologies: Projects
	Advanced Methods
ITMS $558$	Operating System Security

&

## Data Center Operations and Management Certificate

This program is designed for students seeking knowledge that will prepare them for a career in data center operations.

## **Required Courses:**

ITMM $576$	Data Center Management
ITMO 540	Introduction to Data Networks and the
	Internet
ITMO $554$	Operating System Virtualization
ITMT 535	Data Center Architecture

## **Data Management and Analytics Certificate**

This program is designed for students seeking knowledge that will prepare them for careers in data management and analytics.

## **Required Courses**

ITMD 421Data Modeling and ApplicationsITMD 422Advanced Database ManagementITMD 527Data Analytics

# 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
ITMO 557 Storage Technologies
ITMS 548 Cyber Security Technologies
ITMs 588 Incident Response, Disaster Recovery and Business Continuity

#### AND one of the following:

ITMD 526	Data Warehousing	
ITMS $528$	Database Security	
ITMD 529	Advanced Data Analytics	
ITMT 531	Object Oriented System Analysis, Modeling	
	and Design	
Ctudente who have alwaydry completed coursework train		

Students who have already completed coursework, training, or certification equivalent to ITMD 421 may substitute a fourth course from the above list.

## Digital Voice and Data Communication Technologies Certificate

This program is designed for students seeking knowledge that will prepare them for careers in digital voice and data communications.

## **Required Courses**

- ITMO 540 Introduction to Data Networks and the Internet
- ITMO 545 Telecommunications Technology
- ITMO 546 Voice Communications Over Data Networks

#### AND one of the following:

ITMO $541$	Network Administration and Operations
ITMO $547$	Voice Communications Over Data Networks:
	Projects & Advanced Methods
ITM 575	Networking & Telecommunications Management

Students who have already completed coursework, training, or certification equivalent to ITMO 540 may substitute a fourth course from the above list.

## Information Technology Innovation, Leadership and Entrepreneurship 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.

## **Required Courses**

ITMM 571	Project Management for Information
	Technology Management
ITMM 581	IT Entrepreneurship
ITMM 582	Business Innovation

## AND one of the following:

Any ITMM	Elective	
INTM $511$	Industrial Leadership	
INTM $515$	Advanced Project Management	
INTM $522$	Computers in Industry	
INTM $534$	Resource Management	
INTM $543$	Purchasing	
TECH $581$	Consulting for Technical Professionals	
Students who have already completed coursework,		

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.

## System Administration Certificate

This program is designed for students seeking knowledge that will prepare them for a career as a systems administrator.

## One of the following two six-credit-hour courses:

ITMO $551$	Distributed Workstation System
	Administration
ITMO $552$	ClientServer System Administration

## Systems Analysis Certificate

This program is designed for students seeking knowledge that will prepare them for a career as a systems analyst.

## **Required Courses**

- ITMM 571 Project Management for Information Technology
- ITMM 572 Process Engineering for Information Technology Managers
- ITMT 531 Object Oriented System Analysis, Modeling and Design

## AND two of the following:

ITMO $456$	Introduction to Open Source Operating
	Systems
ITMO $544$	Cloud Computing Technologies
ITMO $554$	Operating System Virtualization
ITMS $558$	Operating System Security
ITMM 571	Project Management for Information
	Technology Management

## AND one of the following:

ITMD $511$	Application Development Methodologies
ITMD 532	UML Based Software Development
ITMD $534$	Human Computer Interaction
ITMD 536	Software Testing and Maintenance
INTM $522$	Computers in Industry
TECH 581	Consulting for Technical Professionals

Students who have already completed coursework, training, or certification equivalent to ITMM 571 may substitute a fourth course from the above list.

## Web Design and Application Development Certificate

This program is designed for students seeking knowledge that will prepare them for careers in Web design and application development.

## **Required Courses**

ITMD 461Internet Technologies & Web DesignITMD 562Web Application Development

## AND two of the following:

ITMD $534$	Human Computer Interaction	
ITMD $555$	Intelligent Device Applications	
ITMD 563	Intermediate Web Application Development	
ITMD $564$	Advanced Web Application Development	
ITMD $565$	Rich Internet Applications	
ITMD $566$	Service-Oriented Architectures	
ITMD $569$	Topics in Application Development	
Students who have already completed coursework, train-		
ing, or certification equivalent to ITMD 461 may substi-		

tute a fourth course from the above list.

## **Accelerated Courses**

The program may offer accelerated courses for credit in several areas of information technology & management. (Students should see the definition of accelerated courses within the front section of this bulletin).

Accelerated courses provide an opportunity for degree seeking students at IIT to complete graduate degree

requirements in a shorter time period. If taken by nondegree seeking students, all courses may be later applied toward the Master of Information Technology and Management degree or the Master of Cyber Forensics and Security degree for those who apply and are accepted to the degree program.

# CourseDescriptions

Numbers in parentheses indicate class, lab and credit hours, respectively.

# Information Technology & Management: Development

#### ITMD 411

## Intermediate Software Development

This course covers a broad spectrum of object-oriented programming concepts and application programming interfaces. The student considers the details of object-orientated 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. Hands-on exercises reinforce concepts taught throughout the course. Prerequisite(s): [(ITM 311)]

(2-2-3)

#### **ITMD 412**

## Advanced Structured & Systems Programming

Structured programming continues with advanced concepts including strings, arrays, pointers, data structures, file manipulation, and dynamic memory management. Students create more 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.

Prerequisite(s): [(ITM 312)] (2-2-3)

#### **ITMD 421**

#### Data Modeling & Applications

Basic data modeling concepts are introduced. Hands-on database design, implementation, and administration of single-user and shared multi-user database applications using a contemporary relational database management system. (2-2-3)

#### ITMD 422

#### Advanced Database Management

Advanced topics in database management and programming including client server application development are introduced. Expands knowledge of data modeling concepts and introduces object-oriented data modeling techniques. Students will learn the use of Structured Query Language in a variety of application and operating system environments. Prerequisite(s): [(ITM 421) OR (ITM 421)] (3-0-3)

## ITMD 460

#### Fundamentals of Multimedia

Students are introduced to computer-based multimedia theory, concepts, and applications. Topics include desktop publishing, hypermedia, presentation graphics, graphic images, animation, sound, video, multimedia on the World Wide Web and integrated multimedia authoring techniques. (2-2-3)

## ITMD 461

## Internet Technologies & Web Design

This course will cover the creation of Web pages and sites using HTML, CSS, Javascript and graphical applications. Networked multimedia distribution technologies are also explored. The design of effective Web site including page layout, user interface design, graphic design, content flow and site structure as well as management of Web site resources including intranet management and design considerations are addressed. Students design and create a major Web site with multiple pages and cross-linked structures. (2-2-3)

# 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 lifecycle, 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): [(ITM 411) OR (ITM 412) OR (ITMD 411) OR (ITMD 412)]

# (2-2-3)

## 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): [(ITM 411) OR (ITMD 411)]

(2-2-3)

## 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): [(ITM 411) OR (ITMD 411)] (2-2-3)

#### **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 & Applications**

This course covers both concepts and practical applications of client server systems, a common form of distributed system in which software is split between server tasks and client tasks. Both central and distributed server models will be studies, with particular focus on middleware, systems planning, and data access. The course includes hands-on development of client-server applications in database systems.

Prerequisite(s): [(ITM 421) OR (ITMD 421)] (2-2-3)

#### **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): [(ITM 421) OR (ITMD 421)] (3-0-3)

## ITMD 527

#### **Data Analytics**

This is a hands-on course that focuses on the creation, maintenance, and analysis of large informatics databases. Concepts such as data modeling, probability, linear regression, and statistical data analysis are covered in depth. In addition, this course will use large simulated equities, healthcare, insurance, and banking database systems. The student is expected to have a working understanding of relational database concepts as well as SQL.

Prerequisite(s): [(ITM 422) OR (ITMD 422)] (3-0-3)

## 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): [(ITM 527) OR (ITMD 527)] (3-0-3)

#### **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): [(ITM 412) OR (ITMD 412)] (3-0-3)

## ITMD 534

#### Human & 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. (3-0-3)

#### **ITMD 536**

#### Software Testing & 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): [(ITM 471) OR (ITM 571) OR (ITMM 471) OR (ITMM 571)] (3-0-3)

#### **ITMD 555**

#### 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. This course may be taken more than once but only 6 hours of ITM 455/555 or ITMD 455/555 credit may be applied to a degree. (2-2-3)

#### **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.

Prerequisite(s): [(ITM 461) OR (ITMD 461)] (2-2-3)

#### **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): [(ITM 411) OR (ITMD 411)] AND [(ITM 461) OR (ITMD 461)] (2-2-3)

## 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): [(ITM 563) OR (ITMD 563)] (2-2-3)

#### **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. Prerequisite(s): [(ITM 461) OR (ITMD 461)]

(2-2-3)

## **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): [(ITM 411 or ITMD 411)] AND [(ITM 461 or ITMD 461)]

# (2-2-3)

# 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 ITM 469/569 or ITMD 469/569 credit may be applied to a degree. (Credit: Variable)

## Information Technology & Management: Management

#### 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. (3-0-3)

#### **ITMM 571**

# Project Manangement for Information Technology Management

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. (3-0-3)

#### 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-theart software tools for hands-on experiential learning.

Prerequisite: [(ITM 471) OR (ITMM 471) OR (ITM 571) OR (ITMM 571)] (3-0-3)

## ITMM 573

#### **Building & 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: [(ITM 471) OR (ITMM 471) OR (ITM 571) OR (ITMM 571)] (3-0-3)

## 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. (3-0-3)

#### ITMM 575

#### Networking & Telecommunicastions 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. Prerequisite: [(ITM 441) OR (ITMO 441) OR (ITM 541) OR (ITMO 541)].

(3-0-3)

## 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: [(ITM 535) OR (ITMO 535)]

(3-0-3)

## ITMM 581

#### **IT Entreprenseurship**

This course prepares students to become leaders in information technology and to build ITM companies. Students design an develop a prototype ITM product and prepare a business plan and venture proposal presentation. (2, 0, 2)

(3-0-3)

## 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.

(3-0-3)

#### 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.

# (3-0-3)

## ITMM 585

### Legal & 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.

(3-0-3)

#### 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. (3-0-3)

# Information Technology & Management: Operations

#### **ITMO 456**

#### Introduction to Open Source Operating Systems

Students learn to set up and configure an industry-standard, open-source operating system including system installation and basic system administration. Also addressed are applications and graphical user interfaces as well as support issues for open-source software. (2-2-3)

#### **ITMO 540**

## Introduction to Data Networks & 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. (2-2-3)

#### **ITMO 541**

#### **Network Administration & 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: [(ITM 440) OR (ITMO 440) OR (ITM 540) OR (ITMO 540)] (2-2-3)

## ITMO 542

## Wireless Technologies & 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.

 $\begin{array}{l} \mbox{Prerequisite(s):} \ [(\mbox{ITM 440}) \ \mbox{OR (ITM 540}) \ \mbox{OR (ITM 540)} \\ \mbox{OR (ITMO 540)}] \end{array}$ 

(3-0-3)

## 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. (2-2-3)

#### **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. (3-0-3)

#### **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.

Prerequisite(s): [(ITM 440) OR (ITMO 440) OR (ITM 540) OR (ITMO 540)]

(3-0-3)

#### **ITMO 547**

# Telecommunications Over Data Networks: Projects & 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 webbased 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.

(2-2-3)

#### ITMO 551

## Distributed Workstation System Administration

Students learn to set up and maintain PC workstations and servers and to administer PC servers and networks. Topics include hardware requirements; software compatibility; and system installation, configuration and options and post-installation topics; administrative practices required for file system security; process management; performance monitoring and tuning; storage management; back-up and restoration of data; and disaster recovery and prevention. A group project or research paper will demonstrate mastery of the subject. (4-4-6)

## ITMO 552

#### **Client-Server System Administration**

Students learn to setup and configure a contemporary operating system, including the actual installation of the operating system on the student work-station, in a networked client-server environment. User account management, security, printing, disk configuration, and backup procedures are addressed, with particular attention to coverage of TCP/IP and TCP/IP applications. System installation, configuration and administration issues as well as network file systems, network access and compatibility with other operating systems are also addressed. A group project or research paper will demonstrate mastery of the subject. (4-4-6)

#### 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. (2-2-3)

#### ITMO 556

#### **Itelligent 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 the 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 ITMO 456/556 credit may be applied to a degree.

(2-2-3)

#### 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. (3-0-3)

# Information Technology & Management: Security

## 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): [(ITM 411) OR (ITMD 411)] (3-0-3)

#### **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. Prerequisite(s): [(ITM 421) OR (ITMD 421)]

## (3-0-3)

#### ITMS 538 Cyber Forensie

## 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.

## (2-2-3)

#### 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): [(ITM 538) OR (ITMS 538)] (2-2-3)

## ITMS 543

#### Vulnerability Analysis & 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.

 $\begin{array}{l} \mbox{Prerequisite(s):} \ [(ITM \ 440) \ OR \ (ITMO \ 440) \ OR \ (ITM \ 540) \\ OR \ (ITMO \ 540)] \end{array}$ 

(2-2-3)

#### **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 selfcontained team project that, if the student wishes, can he extended into a full operational security system in a follow-course,

 $\label{eq:prerequisite} \begin{array}{l} \mbox{Prerequisite(s): [(ITM 440) OR (ITM 540) OR (ITMO 440) OR (ITMO 540)]} \end{array}$ 

(2-2-3)

## **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): [(ITM 448) OR (ITM 548) OR (ITMS 448) OR (ITMS 548)] (2-2-3)

#### 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.

Prerequisite(s): [(ITM 538) OR (ITMS 538)]

(2-2-3)

## 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.

Prerequisite: [(ITM 456) OR (ITMO 456)] (2-2-3)

## **ITMS 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. (3-0-3)

## **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. (3-0-3)

# **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 ITM 479/579 or ITMS 479/ITMS 579 credit may be applied to a degree. (Credit: Variable)

#### **ITMS 588**

#### Incident Response, Disater Recovery, & 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. (3-0-3)

## Information Technology & Management: Theory and Technology

#### **ITMT 492**

#### Embedded Systems & Reconfigurable Logic Design

This course covers reconfigurable intelligent devices programmed with modern high level languages focusing on design and integration to modern environments. The course will also cover the topic and deployment of wireless sensor networks and the use of rapid prototyping for commercial application. Students will discover hardware, software and firmware design trade-offs as well as best practices in current embedded systems development. A final project will integrate course topics into a system using an embeddable single-board microcontroller.

Prerequisite(s): [(ITM 311) OR (ITM 312)] (3-0-3)

## **ITMT 495**

#### **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 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): [(ITM 411) OR (ITMD 411)] (3-0-3)

## **ITMT 531**

## **Object-Oriented System Analysis, Modeling & 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. (3-0-3)

## **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 learned 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. Requires knowledge of C++. (3-0-3)

#### **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. (3-0-3)

#### **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 focus will be given to modern in educational settings. programming environments and models for developing instructional materials. (3-0-3)

## **ITMT 593**

#### Embedded Systems

This course introduces embedded systems concepts and technology, illustrates the trade-offs which occur as part of embedded systems design, as well as providing practical applications of embedded systems technology. Particular emphasis is given to embedded systems hardware, software and development tools. The course labs include hands-on development of several stand-alone embedded applications using development tools such as compilers, simulators and evaluation boards. Prerequisite: ITM 301 or equivalent computer architecture course; C/C++ programming experience. (2-2-3)

## **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)

## Technology

#### **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 professionals.

(3-0-3)

# Undergraduate Courses Available to Graduate Students as Prerequisites Only

Note: Students may take up to an approved number of the following courses.

ITM 301 Introduction to Contemporary Operating Systems and Hardware I

## ITM 301

Introduction to Contemporary Operating Systems and Hardware II

ITM 301 Introduction to Software Development

ITM 301 Introduction to Systems Software Programming

# **Intellectual Property Management and Markets**

## **Program Director:**

Herb Munsterman 312.906.5225 hmunsterman@kentlaw.iit.edu

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. IIT'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.

# Degree Offered

Master of Intellectual Property Management and Markets

# **Degree Requirements**

30 credit hours

No thesis is required, but there is a capstone/project course requirement (2 credits). 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. The IPPM 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.

# **Course Descriptions**

## **IPMM 500**

## Context/Introduction & 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. (4-0-4)

#### **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. (3-0-3)

#### **IPMM 502**

#### IAM Methodologies & 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. (3-0-3)

#### IPMM 503 Acquiring IP

#### Acquiring IF

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. (3-0-3)

## IPMM 504

## IP & 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. (3-0-3)

#### **IPMM 505**

#### **Global IP Management**

This is a broad course covering the critical areas of IP portfolio management in a variety of business settings. The course focuses on the role of innovation and intellectual property within the global operation of companies and addresses strategies for global IP coverage, including decisions on when, where and how to seek IP protection on a cost-effective basis. This course will also teach principles of IT portfolio management that affect the operations, planning, knowledge management, and new product/process development of businesses trading internationally. Various scenarios and cases will be discussed, such as technological discontinuities, mergers, divestitures, regulations, nationalization of corporate assets, and reorganizations. (3-0-3)

#### **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"). (3-0-3)

#### **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. (2-0-2)

# Chicago-Kent College of Law

565 W. Adams St. Chicago, IL 60661 312.906.5000 admissions@kentlaw.iit.edu www.kentlaw.iit.edu

**Dean:** Harold J. Krent

filatolu J. Klein

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

# **Degrees Offered**

Juris Doctor (J.D.) Master of Laws (LL.M.) 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.

Doctor of the Science of Law (J.S.D.)

# **Joint-Degree Programs**

J.D./LL.M. in Family Law J.D./LL.M. in Financial Services Law J.D./LL.M. in Taxation With Stuart School of Business: J.D./M.B.A. J.D./M.P.A. J.D./M.S. in Environmental Management and Sustainability J.D./M.S. in Finance

With University of Illinois at Chicago: J.D./Master of Public Health (M.P.H.)

# **Certificate Programs**

To earn certificates, students must be admitted and enrolled as law students in the J.D. program.

Business Law Criminal Litigation Environmental and Energy Law Intellectual Property Law International and Comparative Law Labor and Employment Law Litigation and Alternative Dispute Resolution Public Interest Law

# **Research Centers**

# Center for Access to Justice and Technology

Chicago-Kent College of Law established the Center for Access to Justice and Technology (CAJT) to make justice more accessible to the public by promoting the use of the Internet in the teaching, practice, and public access to the law. The one focus of CAJT is to help pro se litigants obtain greater access to justice. Many self-

# Center for Information, Society, and Policy

The Center for Information, Society, and Policy is a collaboration among Chicago-Kent public policy experts and IIT 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 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.

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.

under the Illinois Open Meetings Act, the Illinois Free-

dom of Information Act, and similar statutes. Under the

supervision of faculty, Chicago-Kent students interview

and counsel clients, conduct factual investigations and

legal research, develop case strategies, collect and analyze

documents, and help with litigation.

nology, and human rights.

## **Center for Open Government**

The Center for Open Government is an initiative to help ensure transparency, accountability, and responsibility in state and local government. Housed in the Chicago-Kent Law Offices as part of the law school's clinical education program, the Center for Open Government focuses on pro bono cases challenging closed government processes

## **Global Law and Policy Initiative**

The Global Law and Policy Initiative (GLAPI) aims to develop a better understanding of the evolving global environment and to strengthen democratic institutions wherever they may be found. It brings together the Chicago-Kent faculty, the Chicago community, and Chicago-Kent students who have an active interest in broadening their involvement in international law. In ad-

## 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 in-

## 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 prodition, GLAPI provides a forum to promote the exchange of views and experiences among academics, policymakers, and business leaders about critical issues of global policy. GLAPI-sponsored dialogues cover a wide range of topics, including the rule of law, international policing, anti-corruption strategies, economic development, tech-

tegrate 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.

fessional community to train students and professionals, monitor policies and trends, and reflect upon major issues in a neutral setting.

## Institute for Science, Law and Technology

The Institute for Science, Law and Technology is a joint venture of the academic units of IIT designed to meet the growing need for science- and law-trained professionals capable of addressing the complex issues that arise in a global, technologically driven marketplace of ideas, product standards, and conflicts. The most difficult challenges at the intersection of law and science today arise from new technologies. New possibilities in biotechnology, such as cloning and genetic engineering, raise diffi-

## Institute on the Supreme Court of the United States

The Institute on the Supreme Court of the United States (ISCOTUS) educates internal and external audiences about the Court and its role in our constitutional system of government. ISCOTUS's Academic Center is designed to provide new opportunities that showcase the significant intellectual contributions of Chicago-Kent's faculty and to give students the opportunity to learn from apcult questions about ethics and challenge traditional legal concepts. Environmental concerns about the generation of greenhouse gases, rain forest devastation, and sustainable development challenge public policy. The Internet and other new information networks escape legal control at national boundaries. The Institute serves as a cross-disciplinary forum for lawyers, scientists, ethicists, psychologists, businesspeople, designers, and engineers to confront the challenges presented by new technologies.

pellate advocates with experience in the Court and from prominent jurists. The other two main components of ISCOTUS are the Oyez Project, a multimedia archive devoted to Court and its work, and the Civic Education Project, which merges ISCOTUS's academic and technological dimensions to promote public education about the Court.

## **Jury Center**

The Jury Center serves as a clearinghouse for information about the jury to academics, students, judges, lawyers, and members of the press and public. The Center's website provides a centralized resource for jury studies and includes an annotated bibliography with summaries of recent and forthcoming academic articles on capital juries, comparative jury systems, history of juries, jury behavior, jury selection, and public policy; a collected list of law review symposia on the jury; and links to other jury resources. The Jury Center also undertakes special projects, such as an evaluation of state court websites for prospective jurors.
# **Research and Training Facilities**

# The Downtown Campus Library

The Downtown Campus Library contains more than 500,000 print volumes and countless electronic subscriptions to a wide variety of online material. It supports the Chicago-Kent College of Law and other IIT graduate programs taught at the Downtown Campus. Areas of collection strength include law, business, and international relations, and the library is a depository for materials from the European Union, the United Nations, and the United States federal government. The library provides

both wired and wireless access to the Internet, seats more than 400 people, and contains 10 group study rooms that may be reserved by IIT students. Seating throughout the library provides access to all of the online research systems, both remote (e.g., LexisNexis, Westlaw, and numerous other subscription databases in law and business) and internal, such as Web-based interactive tutorials, computer-assisted legal instruction, productivity tools, and e-mail.

# **Computer Facilities**

Chicago-Kent boasts a computer network that is among the most technologically advanced of any law school in the nation. Wireless technology allows complete access to the network and is available throughout much of the building, including the atrium area that spans the concourse, first and second floors; all floors of the library; many classrooms; and the student lounge. Students with laptops can also use network ports available almost everywhere in the building. Every seat in the library and almost every classroom seat has a hardwired computer

# 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

# **Research and Clinical Training Areas**

# Legal Research and Writing

Chicago-Kent has one of the most rigorous and comprehensive legal research and writing programs in the country. The required five-course curriculum introduces students to basic and advanced research techniques; memorandum and brief writing; transactional writing and

# **Clinical Education**

The Law Offices of Chicago-Kent, a teaching law office located in the law school, is one of the largest in-house clinical programs in the United States. The center is staffed by more than a dozen full-time attorneys and serves more than 1,000 clients each year. Students who intern in the law offices have the opportunity to work on cases in a wide variety of clinical practice areas—civil practice, criminal law, entrepreneurial law, environmental law, family law, health and disability law, immigration law, intellectual property law, mediation, open government/government watchdog law (Center for Open Government), and tax law—under the supervision of a clinical professor. Other skills training opportunities are node with adjacent power connections. Networked workstations are devoted to student use throughout the building in three computer labs as well as in student lounges, the library, and even the cafeteria and atrium. Webbased 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 nation. Planned for both law school instruction and actual legal proceedings, the Marovitz Courtroom incorporates the latest computer and audiovisual technology in a traditional setting.

client representation; and specialized research and writing in such areas as securities, labor and employment, environmental, international, public interest, or intellectual property law.

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. 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.

# Faculty

Visit the Chicago-Kent Web site for detailed faculty biographies (http://www.kentlaw.iit.edu/faculty).

Adams, Susan J., Professor of Legal Research and Writing, Associate Director of the Legal Research and Writing Program, and Director of Writing Services. B.A., M.A., University of Wisconsin; J.D., Valparaiso University School of Law.

Andrews, Lori B., Distinguished Professor of Law and Director of the Institute for Science, Law and Technology. B.A., Yale College; J.D., Yale Law School.

Atuahene, Bernadette, Associate Professor of Law. B.A., University of California-Los Angeles; M.P.A., Harvard University; J.D., Yale Law School.

Bailey, Kimberly D., Assistant Professor of Law. B.A., Indiana University-Bloomington; J.D., University of Michigan Law School.

Baker, Katharine K., Professor of Law. B.A., Harvard-Radcliffe College; J.D., University of Chicago Law School.

Batlan, Felice, Associate Professor of Law and Co-Director of the Institute for Law and the Humanities. B.A., Smith College; J.D., Harvard Law School; Ph.D., New York University.

Birdthistle, William A., Associate Professor of Law. B.A., Duke University; J.D., Harvard Law School.

Bosselman, Fred P., Professor of Law Emeritus. A.B., University of Colorado; J.D., Harvard Law School.

Brill, Ralph L., Professor of Law. A.B., J.D., University of Illinois, Urbana-Champaign.

Brody, Evelyn, Professor of Law. B.A., Yale University; J.D., Georgetown University Law Center.

Brown, Bartram S., Professor of Law and Co-Director of the Program in International and Comparative Law. B.A., Harvard University; J.D., Columbia Law School; Ph.D., Graduate Institute of International Studies (Switzerland).

Brown, Gerald, Senior Instructor and Director of the Graduate Program in Taxation. B.S.C., DePaul University; J.D., University of Chicago.

Buccafusco, Christopher J., Assistant Professor of Law. B.S., Georgia Institute of Technology; J.D., University of Georgia School of Law.

Chapman, Howard S., Professor of Law. B.S., J.D., University of Illinois, Urbana-Champaign.

Cho, Sungjoon, Professor of Law. LL.B., M.P.A., Seoul National University (Korea); LL.M., University of Michigan Law School; S.J.D., Harvard Law School. Collens, Lewis M., President Emeritus of Illinois Institute of Technology and Professor of Law Emeritus. B.A., M.A., University of Illinois, Urbana-Champaign; J.D., University of Chicago.

Conviser, Richard J., Professor of Law. B.A., J.D., University of California-Berkeley; Dr. Jur., University of Cologne (Germany).

Coyne, Daniel T., Clinical Professor of Law. B.A., University of Illinois-Chicago; J.D., The John Marshall Law School.

De Armond, Elizabeth, Professor of Legal Research and Writing. B.S., Georgia Institute of Technology; J.D., University of Notre Dame Law School; LL.M., Harvard Law School.

de Freitas, Rhonda E., Clinical Assistant Professor of Law. B.A., Florida International University; J.D., Loyola University of Chicago School of Law.

Decatorsmith, Jonathan P., Clinical Assistant Professor of Law. B.A., University of Illinois, Urbana-Champaign; J.D., University of Colorado Law School.

Eglit, Howard C., Professor of Law. B.A., University of Michigan; J.D., University of Chicago Law School.

Ehrenberg, Suzanne, Professor of Legal Research and Writing. B.A., Williams College; J.D., University of Chicago Law School.

Epstein, Wendy Netter, Visiting Assistant Professor of Law. B.A., University of Illinois, Urbana-Champaign; J.D., Harvard Law School.

Erickson, Hon. David A., Director of the Trial Advocacy Program, Senior Instructor, and Director of the Program in Criminal Litigation. B.A., Northern Illinois University; J.D., The John Marshall Law School.

Gerber, David J., Distinguished Professor of Law and Co-Director of the Program in International and Comparative Law. B.A., Trinity College; M.A., Yale University; J.D., University of Chicago Law School.

Godfrey, Douglas W., Professor of Legal Research and Writing. B.A., M.A., University of Illinois, Urbana-Champaign; J.D., University of Michigan Law School.

Goldman, Jerry, Research Professor of Law. A.B., M.A., Brooklyn College; Ph.D., Johns Hopkins University.

Gonzalez, Richard J., Clinical Professor of Law. B.A., Northwestern University; J.D., Ohio State University College of Law.

Greenberg, Sanford N., Professor of Legal Research and Writing. A.B., Princeton University; J.D., George Washington University Law School; M.A., Ph.D., University of California-Berkeley. Gross, Vivien C., Clinical Professor of Law. B.A., Northwestern University; M.A., University of Illinois, Urbana-Champaign; J.D., Indiana University School of Law-Bloomington.

Hablutzel, Philip N., Professor of Law and Director of the Institute of Illinois Business Law. B.A., Louisiana State University; M.A., J.D., University of Chicago.

Harding, Sarah K., Associate Professor of Law and Associate Dean for Faculty. B.A., McGill University (Canada); LL.B., Dalhousie Law School (Canada); B.C.L., Oxford University (England); LL.M., Yale Law School.

Harpalani, Vinay, Visiting Associate Professor of Law. B.A., University of Delaware; M.S., Master of Bioethics, Ph.D., University of Pennsylvania; J.D., New York University School of Law.

Harper, Heather F., Clinical Assistant Professor of Law. B.A., Northwestern University; J.D., Boston College Law School.

Harris, Edward C., Associate Professor of Legal Writing and Assistant Dean for the International LL.M. Programs. B.A., Loyola University-Chicago; J.D., IIT Chicago-Kent College of Law.

Harris, Steven L., Professor of Law. B.A., J.D., University of Chicago.

Haugh, Todd, Visiting Assistant Professor of Law. B.A., Brown University; J.D., University of Illinois College of Law.

Heyman, Steven J., Professor of Law. A.B., Harvard College; J.D., Harvard Law School.

Johnson, Kari L. Aamot, Professor of Legal Research and Writing. B.A., St. Olaf College; J.D., University of Minnesota Law School.

Keller, Cherish M., Assistant Professor of Legal Research and Writing for LL.M. Program. B.S., University of Illinois, Urbana-Champaign; J.D., IIT Chicago-Kent College of Law.

Kentra, Pamela A., Clinical Professor of Law. B.A., University of Illinois, Urbana-Champaign; J.D.,IIT Chicago-Kent College of Law.

Kling, Richard S., Clinical Professor of Law. B.A., University of Illinois-Chicago; J.D., Northwestern University School of Law.

Koch, Valerie Gutmann, Visiting Assistant Professor of Law. A.B., Princeton University; J.D., Harvard Law School.

Kraus, Edward, Clinical Associate Professor of Law. B.A., University of Michigan; J.D., Georgetown University Law Center. Krent, Harold J., Professor of Law and Dean, IIT Chicago-Kent College of Law. A.B., Princeton University; J.D., New York University School of Law.

Laser, Gary S., Associate Professor of Law, Director of Clinical Education, and Co-Director of the Program in Criminal Litigation. B.B.A., J.D., University of Miami.

Leader, Laurie E., Clinical Professor of Law. A.B., Washington University; J.D., Cleveland-Marshall College of Law.

Lee, Edward, Professor of Law and Director of the Program in Intellectual Property Law. B.A., Williams College; J.D., Harvard Law School.

Malin, Martin H., Professor of Law and Director of the Institute for Law and the Workplace. B.A., Michigan State University; J.D., George Washington University Law School.

Marder, Nancy S., Professor of Law, Director of the Jury Center, and Co-Director of the Institute for Law and the Humanities. B.A., Yale University; M.Ph., University of Cambridge; J.D., Yale Law School.

Mencini, Ana Mendez, Clinical Assistant Professor of Law. B.A., Lake Forest College; M.A., DePaul University; J.D., IIT Chicago-Kent College of Law.

Munsterman, Herbert F., Lecturer and Director of the Intellectual Property Management and Markets Program. B.S., Iowa State University; M.S., Northwestern University; J.D., Drake University Law School.

Nahmod, Sheldon H., Distinguished Professor of Law. A.B., A.M.R.S., University of Chicago; LL.B., LL.M., Harvard Law School.

Perritt, Henry H., Jr., Professor of Law and Director of the Graduate Program in Financial Services Law. S.B., S.M., Massachusetts Institute of Technology; J.D., Georgetown University Law Center.

Piatt, Mickie A., Associate Professor of Law and Deputy Director of the Program in Intellectual Property Law. B.A., M.L.S., J.D., University of Texas-Austin.

Potts, Natalie Brouwer, Clinical Assistant Professor of Law and Director of the Center for Open Government. B.A., University of Chicago; J.D., Cornell Law School.

Rosado Marzán, César F., Assistant Professor of Law. B.A., Haverford College; M.A., Ph.D., Princeton University; J.D., University of Pennsylvania Law School.

Rosen, Mark D., Professor of Law. B.A., Yale College; J.D., Harvard Law School.

Ross-Jackson, Marsha L., Assistant Dean for Student Professional Development, Executive Director of the Institute for Law and the Workplace, and Lecturer. B.A., Hampton University; M.P.A., Roosevelt University J.D., DePaul University College of Law. Rudstein, David S., Professor of Law and Co-Director of the Program in Criminal Litigation. B.S., LL.M., University of Illinois, Urbana-Champaign; J.D., Northwestern University School of Law.

Schmidt, Christopher W., Assistant Professor of Law. B.A., Dartmouth College; M.A., Ph.D., Harvard University; J.D., Harvard Law School.

Schwartz, David L., Associate Professor of Law. B.S., University of Illinois, Urbana-Champaign; J.D., University of Michigan Law School.

Scodro, Michael A., Assistant Professor (on leave). B.A., Dartmouth College; J.D., Yale Law School.

Shapiro, Carolyn, Associate Professor of Law. B.A., University of Chicago; M.A., University of Chicago Harris Graduate School of Public Policy; J.D., University of Chicago Law School.

Sowle, Stephen D., Assistant Dean for Academic Administration and Student Affairs and Senior Lecturer. B.A., Williams College; J.D., Yale Law School.

Spak, Michael I., Professor of Law. B.S., J.D., DePaul University; LL.M., Northwestern University School of Law.

Staudt, Ronald W., Professor of Law and Director of the Center for Access to Justice and Technology. B.S., B.A., St. Joseph's College; J.D., University of Chicago Law School.

Steinman, Joan E., Distinguished Professor of Law. A.B., University of Rochester; J.D., Harvard Law School.

Stern, Stephanie M., Associate Professor of Law. B.A., Brown University; J.D., Yale Law School. Stewart, Margaret G., Professor of Law. B.A., Kalamazoo College; J.D., Northwestern University School of Law.

Stiverson, Keith Ann, Director of the IIT Downtown Campus Library and Senior Lecturer. B.S., Rio Grande College; M.S.L.S., Catholic University of America; J.D., Georgetown University Law Center.

Streseman, Kent D., Clinical Associate Professor of Appellate Advocacy and Director, Ilana Diamond Rovner Program in Appellate Advocacy. B.A., University of California-Davis; J.D., Cornell Law School.

Strubbe, Mary Rose, Professor of Legal Research and Writing, Director of the Legal Research and Writing Program, and Assistant Director of the Institute for Law and the Workplace. B.A., Mundelein College; J.D., IIT Chicago-Kent College of Law.

Tarlock, A. Dan, Distinguished Professor of Law and Director of the Program in Environmental and Energy Law. A.B., LL.B., Stanford University.

Walters, Adrian J., Ralph L. Brill Professor of Law. B.A., University of Cambridge; Graduate Diploma in Law, Nottingham Polytechnic.

Warner, Richard, Professor of Law and Faculty Director of the Center for Law and Computers. B.A., Stanford University; Ph.D., University of California-Berkeley; J.D., University of Southern California Law Center.

Wright, Richard W., Distinguished Professor of Law. B.S., California Institute of Technology; J.D., Loyola University of Los Angeles; LL.M., Harvard Law School.

# **Admission Requirements**

Applicants for admission to Chicago-Kent must have received a bachelor's degree from an accredited college or university prior to beginning classes at the law school. Students are admitted to the law school based on the information contained in their applications, their LSAT scores, undergraduate records, personal statements, and their letters of recommendation.

# Juris Doctor (J.D.)

The college offers both full-time and part-time divisions. Entrance, scholastic, and graduate requirements are the same for both divisions, and full-time faculty teach in both divisions. Entering classes begin only in the fall, but incoming first-year evening students may take one course during the summer semester before their first year. Three years are normally required for full-time day division students to complete the 87 credit hours needed for the Juris Doctor (J.D.) degree. Evening division and part-time

Master of Laws (LL.M.)

Chicago-Kent offers Master of Laws (LL.M.) degree programs in taxation, international and comparative law, international intellectual property law, family law, and financial services 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

# 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

# J.D./LL.M. in Family Law

Chicago-Kent offers a combined J.D./LL.M. program in family law that allows students to gain the broad expertise required of contemporary family law practitioners. The practice-oriented curriculum—the only one of its

# J.D./LL.M. in Financial Services Law

Deregulation of financial services, tax reforms, and revolutionary market forces have created an environment in which attorneys and other professionals must broaden their knowledge and sharpen their analytical skills and understanding in these areas. The graduate program in financial services law offers both full- and part-time stuAll candidates must take the LSAT and register with the LSAC Credential Assembly Service. For additional information on admission requirements, potential students should contact the law school admissions office at 312.906.5020 or visit the Chicago-Kent admissions Web site at www.kentlaw.iit.edu/admissions.

day division students normally take four years, including one summer session, to graduate. A selection of courses is offered each summer, mostly in the evening. First-year courses are required, while most courses in the second and third years are elective, although the faculty recommends that all students take certain upperclass courses. In addition to traditional courses, the curriculum offers a wide variety of innovative courses and seminars to enrich the student's academic experience.

faculty member. A student may pursue these programs on a full- or part-time basis. The LL.M. in International and Comparative Law is offered to foreign attorneys. Chicago-Kent also offers combined J.D./LL.M. degree programs in taxation, family law, and financial services law, which enable students to earn both degrees after seven semesters in residence instead of eight.

advanced course work, 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.

kind in the United States—encompasses family law and attendant, increasingly complex issues of tax, finance, real estate, business entities, contracts, and child psychology.

dents a unique opportunity to broaden their understanding of the principles underlying increasingly complex systems and services, deepen their knowledge of particular topics of interest, and enhance their skills as professionals. Courses are offered on weekday evenings and on Saturdays.

# J.D./LL.M. in Taxation

The law school offers a combined J.D./LL.M. program in taxation that enables a student to earn both a J.D. and a Master of Laws (LL.M.) in taxation in a total of seven semesters of full-time study, instead of eight. A student may take six LL.M. courses (12 credit hours of coursework) while a J.D. candidate. These 12 credit hours will be applied toward both the J.D. and the LL.M.

# J.D./M.B.A.

A joint degree J.D./M.B.A. program in conjunction with IIT 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 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.

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 IIT Stuart School of Business. The Environmental Management Program is a unique multidisciplinary program integrating engineering, law, and busi-

# J.D./M.S. in Finance

The law school, in conjunction with IIT 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

# J.D./M.P.A.

The law school offers a joint-degree J.D./M.P.A. in conjunction with IIT Stuart School of Business. This pro-

# 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 ness 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.

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.

gram explores practices and policies in the public sector.

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,

## **Business Law**

The Business Law Certificate Program allows students to explore a broad range of business-related topics to build legal careers representing small and large businesses and corporations. Graduates have a solid understanding of the basic principles of business and commercial law and are familiar with the increasingly complex regulatory environment that business lawyers commonly encounter in practice. The curriculum includes traditional subjects such as business organizations, securities regulation, and taxation. It also allows students to focus on individthe student has completed an identified subset of elective courses in the area of specialization.

ual interests by including an extensive array of elective courses such as E-Commerce, International Capital Markets, Employment Relationships, and Futures Regulation. The program requires a total of 24 credit hours emphasizing both theory and practice. Students must take three required courses, two courses from a list of core courses, additional courses from a list of elective courses, and a specialized legal writing course, and must complete an experiential requirement.

# **Criminal Litigation**

Chicago-Kent's Program in Criminal Litigation is designed to give students a comprehensive and balanced professional education to prepare them for the practice of criminal law. To earn the certificate, students must complete 24 credit hours of coursework from an approved

### **Environmental and Energy Law**

The Program in Environmental and Energy Law trains students to be environmental and energy professionals, as well as law practitioners. Taking an interdisciplinary approach to the field's scientific, economic, and ethical aspects, the program immerses students in the statutes and administrative regulations, case decisions, and theoretical underpinnings of environmentalism. The program attracts students from a wide range of professions. A highly regarded faculty teaches a carefully considered

## Intellectual Property Law

Intellectual property lawyers work where the law intersects with technology, science, and the arts to protect their clients' creative products. The field of intellectual property law focuses on issues relating to patents, copyrights, trade secrets, unfair competition, and antitrust. As part of the program's rigorous practical skills training, students learn how to draft intellectual property documents through specialized legal research and writ-

### International and Comparative Law

In a climate of continuous change, Chicago-Kent's Program in International and Comparative Law addresses the law's global implications and extensive reach. Students can learn how to conduct an international business transaction, develop the skills to navigate between different legal regimes, and learn about the legal structures of international institutions and organizations. The program offers opportunities to link coursework to externships, foreign law study, and projects in nations across curriculum. With emphases on both theory and practical skills development, the certificate program represents an opportunity to synthesize the goals of Chicago-Kent's academic program in criminal law with those of the Trial Advocacy Program and the Chicago-Kent Law Offices.

curriculum addressing a wide variety of cutting-edge issues.

Students in the program complete 14 credit hours of approved coursework. If students are full-time, these courses are taken during the second and third years; if students are part-time, courses are taken during the second, third, and fourth years.

ing courses and develop litigation skills by participating in moot court competitions. The program encourages scholarship and discourse among academics, practitioners, and students with events like the Chicago Intellectual Property Colloquium. Students complete 20 credit hours of approved coursework, including courses in patent law, copyright law, and trademark and unfair competition law.

the globe. Students in the program must successfully complete 14 credit hours of course study in international and comparative law, including a 2-credit seminar.

Students can take advantage of the Library of International Relations, which contains a diverse collection of international legal, historical, and business-related reference materials and is a depository library for the United Nations and the European Union.

# Labor and Employment Law

The Program in Labor and Employment Law is the centerpiece of Chicago-Kent's Institute for Law and the Workplace. Through a logical, carefully paced sequence of coursework and practical skills training, the program provides comprehensive, rigorous preparation for the field of labor and employment law. To earn a certificate,

# Litigation and Alternative Dispute Resolution

Chicago-Kent's Program in Litigation and Alternative Dispute Resolution offers an innovative curriculum that stresses the connection between legal doctrine, skills and values, and the art of lawyering. The program provides comprehensive training in trial skills, negotiation, and mediation, and a rigorous curriculum of clinical education. Students in the program complete a series of courses program participants must complete four core courses, a seminar course, a practicum, and additional electives. The core courses are Labor Law, Employment Relationships, Employment Discrimination, and a specialized advanced legal research and writing course in labor and employment law.

that includes alternative dispute resolution, evidence, pretrial litigation, and trial advocacy. In-house clinical education takes place in the Law Offices of Chicago-Kent, the school's acclaimed teaching law firm, where students work with clinical professors on cases in criminal, civil rights, employment, family, health, immigration, and tax law.

# Public Interest Law

The Certificate in Public Interest Law builds on Chicago-Kent's strong public interest tradition and adds a concentrated curriculum to the rich array of activities, courses, and resources that encourage Chicago-Kent students to consider public interest law as a career and prepare students to be effective public interest lawyers. The certificate requires 12 credit hours, including Public Interest Law and Policy and a specialized advanced legal research and writing course concentrating on public interest law. Because the substantive scope of public interest lawyering is so broad, each student meets with the director of the program to plan additional courses and at least one public interest clinic or externship to satisfy individual career and interest objectives. Each

# 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.

# **Course Descriptions**

See the Chicago-Kent College of Law Web site for detailed information about faculty (www.kentlaw.iit.edu/faculty) 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.

An advanced course in litigation technology ensures students are prepared to use computer technology in the courtroom, a critical aspect of contemporary trial practice.

and courses (www.kentlaw.iit.edu/course-descriptions).

# **Department of Mathematics and Science Education**

3424 S. State Street Room 4007 Chicago, IL 60616 312.567.3661 312.567.3659 fax ledermann@iit.edu www.iit.edu/departments/msed

### Chair: TBD

# Director, Graduate Programs:

N. G. Lederman

Mathematics and science education is primarily concerned with all aspects of the teaching and learning of mathematics and/or science at the secondary levels (i.e., grades 6-12). The department offers Professional

# **Degrees Offered**

Master of Science in Mathematics Education Master of Mathematics Education Master of Science in Science Education Master of Science Education

# **Research Areas**

Research areas include informal science/math education, curriculum development, integration of science/math disciplines and across disciplines, and instructional meth-

# Faculty

Lederman, Judith S., Associate Professor and Director of Teacher Education. B.A., Rhode Island College; M.S., Worcester Polytechnic Institute; Ph.D., Curtain University (Australia). Informal science education, curriculum development, integration of science disciplines and across disciplines, and instructional methods.

Lederman, Norman G., Distinguished Professor. B.S., M.S. Bradley University; M.S., New York University; Ph.D., Syracuse University. Students and teachers conceptions of scientific inquiry and nature of science, instructional models, evaluation, and research design. Master's, Master of Science, and Ph.D. degrees in mathematics and science education. The master's programs are specifically focused on experienced teachers, individuals seeking certification and advanced study, or individuals working in educational settings other than schools (e.g., museums, zoos, etc.). Specific attention is placed on curriculum development, evaluation, advanced instructional models, supervision, learning and cognition, and action research.

The Ph.D. programs are designed for those individuals wishing to become university-level teacher educators and researchers. Extensive attention is given to quantitative and qualitative research designs, along with advanced work in evaluation, curriculum analysis, and supervision. Both M.S. and Ph.D. students will be required to complete additional subject matter courses (e.g. science and mathematics) equivalent to 9-12 credit hours.

Doctor of Philosophy in Mathematics Education Doctor of Philosophy in Science Education Doctor of Philosophy in Collegiate Mathematics Education

ods; students and teachers' conceptions of scientific/ mathematic inquiry and nature of science/math, instructional models, evaluation, and research design.

Meyer, Daniel Z., Visiting Assistant Professor. B.A., Swartmore College; Ed.M., Harvard University; Ph.D., Cornell University.

Popovic, Gorjana, Instructor. B.S., University of Belgrade (Serbia); M.S., Ph.D., Illinois Institute of Technology.

# **Admission Requirements**

Bachelor's (or Master's, for Ph.D. programs) degree in mathematics (for mathematics education), science (for science education) or another field with documented evidence of success in working with school-aged youth

GRE score minimum for M.S. applicants:

900 (quantitative + verbal) 2.5 (analytical writing) GRE score minimum for Ph.D. applicants:

1000 (quantitative + verbal) 3.0 (analytical writing) TOEFL minimum  $600/250/80^*$  if from non-English speaking country

A minimum cumulative undergraduate GPA of 3.0/4.0 Two-page professional statement of goals/objectives Curriculum Vita Three letters of recommendation An interview may be required

Additional requirements for Ph.D. programs: Three years of teaching experience. Meeting the minimum standards does not guarantee admission. Test scores and GPA are just two of several important factors considered, and admission decisions are made based upon the totality of the application file.

* Paper-based test score/computer-based test score/internet-based test scoe.

# Master of Science in Mathematics Education (Thesis) Master of Mathematics Education (Professional Master's, Non-Thesis)

33 credit hours

Thesis (Master of Science) or non-thesis (Professional Master's) option

The objective of the master's program is to provide practicing teachers, or individuals in education-related fields, with advanced education in the teaching and learning of mathematics. These advanced studies will enhance graduates' ability to provide meaningful instruction in mathematics; critically analyze and implement empirical research findings in mathematics education; develop and evaluate curriculum; and become a leader in public school education at the state or local levels.

# **Required Courses**

MSED $550$	Clinical Supervision in
	Science/Mathematics
MSED $560$	Research & Evaluation
OR	
MSED $552$	Assessment and Evaluation
MSED $555$	Middle & Secondary Mathematics
	Curriculum
PSYC $588$	Learning, Cognition and Motivation
OR	
MSED $580$	Adolescent Psychology
MSED $501$	Advanced Strategies: Mathematics
MSED 540	Informal Education Practicum

Master of Science Thesis Option (6 credit hours) MSED 591 Thesis Research

# Professional Master's Non-Thesis Option (3 credit hours)

MSED 538 Inquiry & Problem Solving

# And a minimum of three credit hours from the following:

MSED $571$	Problem Solving and Nature of Mathematics
MSED $531$	Professional Development and Practicum in
	Mathematics
MSED 562	Action Research

**AND** nine credits of select coursework from discipline-specific mathematics courses

# Master of Science in Science Education (Thesis Option) Master of Science Education (Professional Master's, Non-Thesis)

## $33 \ \mathrm{credits}$

Thesis (Master of Science) or non-thesis (Professional Master's)

The objective of the M.S. program is to provide practicing teachers, or individuals in education-related fields, with advanced education in the teaching and learning of science. These advanced studies will enhance graduates' ability to provide meaningful instruction in science; critically analyze and implement empirical research findings in science education; develop and evaluate curriculum; and become a leader in public school education at the state or local levels.

# **Required Courses**

MSED $550$	Clinical Supervision
	in Science/Mathematics
MSED 560	Research and Evaluation
OR	
MSED $552$	Assessment and Evaluation
MSED $554$	Middle and Secondary Science Curriculum
PSYC $588$	Learning, Cognition and Motivation
OR	
MSED 580	Adolescent Psychology
MSED $502$	Advanced Strategies: Science
MODD FIG	

MSED 540 Informal Education Practicum

# Master of Science/Mathematics Education

# **Teacher Certification Option**

45 credit hours

The Master of Science/Mathematics Education (Teacher Certification Option) is designed for individuals who already possess a bachelor's degree (preferably in an area of science or mathematics) and wish to pursue both a teaching certification and a master's degree. This accelerated course of study allows the student to achieve certification and a master's degree in just 45 credit hours, instead of the 54 credit hours that would be required if certification and master's degree were pursued separately. Master of Science Thesis Option (6 credit hours) MSED 591 Thesis Research

# Professional Master's Non-Thesis Option:

# (3 credit hours)

MSED 538 Inquiry & Problem Solving

## And a minimum of three credit hours from the following:

MSED 570 Inquiry and Nature of Science MSED 530 Professional Development and Practicum in Science MSED 562 Action Research

**AND** nine credits of select coursework from discipline-specific science courses.

## **Required Courses**

MSED 500	Analysis of Classrooms II (Practicum and
	Seminar)
MSED	Advanced Strategies: Mathematics/Science
501/502	
MSED	Middle and Secondary Science and
554/555	Mathematics Curriculum
MSED $300$	Instructional Methods/Strategies I
$\mathrm{MSED}\ 400$	Instructional Methods/Strategies II
$\mathrm{MSED}\ 538$	Inquiry & Problem Solving
$\mathrm{MSED}\ 540$	Informal Education Practicum and Seminar
$\mathrm{MSED}\ 450$	Professional Internship (6 credit hours)
MSED $550$	Clinical Supervision
	in Science/Mathematics
MSED $552$	Assessment and Evaluation
PSYC $588$	Learning, Cognition, and Motivation
OR	
$\mathrm{MSED}~580$	Adolescent Psychology
ANTD '	

**AND** nine credits from graduate level science/ mathematics courses.

# **Doctor of Philosophy in Mathematics Education**

84 credit hours (Minimum of 51 hours of coursework)

Qualifying exam within the first two years of Ph.D. study Composed of five position statements (ranked by

faculty)

Top three ranked must be defended orally and in writing.

Oral comprehensive exam with the student's graduate committee (The dissertation proposal is presented orally as part of the comprehensive examination).

Oral dissertation defense, involving the final thesis exam

The objective of the Ph.D. program is to provide students with advanced education in the teaching and learning of mathematics. These advanced studies will enable graduates to conduct theoretical and practical research in mathematics education; develop and evaluate curriculum; prepare future teachers; provide professional development to in-service teachers; or become a leader in public school education at the state or local levels.

# Required Courses (30 credit hours)

MSED 601	Critical Analysis in Quantitative Research
MSED 602	Quantitative Research Design and
	Practicum
MSED 603	Critical Analysis in Qualitative Research
MSED 604	Qualitative Research Design and Practicum
MSED $550$	Clinical Supervision in Science/Mathematics
MSED $552$	Assessment and Evaluation
MSED 555	Middle and Secondary Mathematics
	Curriculum
MSED $545$	Statistics I
MSED $546$	Statistics II
PSYC $588$	Learning, Cognition and Motivation I
OR	
MSED 580	Adolescent Psychology

## Electives (minimum of nine credit hours)

MSED 501 Advanced Strategies: Math	
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- MSED 531 Professional Development and Practicum in Mathematics
- MSED 538 Inquiry and Problem Solving
- MSED 540 Informal Education Practicum
- MSED 560 Research & Evaluation
- MSED 562 Action Research

MSED 571 Problem Solving and Nature of Mathematics

- MSED 597 Special Problems (Ethics)
- MSED 594 Special projects (Independent Studies within MSED)

Up to eight hours from discipline-specific graduate coursework

12 credits of select course work from discipline-specific mathematics courses/related fields

Total minimum coursework: 51 credit hours

MSED 691 Ph.D. Thesis Research (minimum 25 credit hours)

Total minimum credits: 84 credit hours

42 maximum transfer of graduate credits from master's (24 credits from coursework/eight credits from research)

# **Doctor of Philosophy in Science Education**

84 credit hours (minimum 51 hours of coursework)

- Qualifying exam within the first two years of Ph.D. study Composed of five position statements (ranked by faculty)
  - Top three ranked must be defended orally and in writing.

Oral comprehensive exam with the student's graduate committee (The dissertation proposal is presented orally as part of the comprehensive examination.)

Oral dissertation defense, involving the final thesis exam

The objective of the Ph.D. program is to provide students with advanced education in the teaching and learning of science. These advanced studies will enable graduates to conduct theoretical and practical research in science education; develop and evaluate curriculum; prepare future teachers; provide professional development to in-service teachers; or become a leader in public school education at the state or local levels.

# Required Courses (30 credit hours)

MSED 601	Critical Analysis in Quantitative Research
MSED 602	Quantitative Research Design and
	Practicum
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MSED 604	Qualitative Research Design and Practicum
MSED $550$	Clinical Supervision in
	Science/Mathematics
MSED $552$	Assessment and Evaluation
MSED $554$	Middle and Secondary Science Curriculum
MSED $545$	Statistics I
MSED $546$	Statistics II
PSYC $588$	Learning, Cognition and Motivation I
OR	
MSED $580$	Adolescent Psychology

## Electives (minimum of nine credit hours)

MSED 502	Advanced Strategies: Science				
MSED $530$	Professional Development and Practicum in				
	Science				
MSED $538$	Inquiry and Problem Solving				
$\mathrm{MSED}\ 540$	Informal Education Practicum				
MSED $562$	Action Research				
$\mathrm{MSED}\ 570$	Inquiry and Nature of Science				
MSED $597$	Special Problems (Ethics)				
$\mathrm{MSED}\ 594$	Special Projects (Independent Studies				
	within MSED)				

Up to eight hours from discipline-specific graduate coursework

12 hours of select course work from discipline-specific science courses/related fields

Total minimum coursework: 51 credit hours

MSED 691 Ph.D. Thesis Research (minimum of 25 credit hours)

Total minimum credits: 84 credit hours

42 maximum transfer of graduate credits from master's (24 credits from coursework/eight credits from research)

# **Doctor of Philosophy in Collegiate Mathematics Education**

85 credit hours beyond the bachelor's degree^{*} Qualifying exam Comprehensive exam Dissertation and Defense

This joint Ph.D. program is offered through the collaboration of the departments of Applied Mathematics (AM) and Mathematics and Science Education (MSED). The objective of the program is to provide advanced education in the teaching and learning of collegiate mathematics through coursework and original research. These advanced studies will enable graduates to teach a wide range of college level mathematics courses, conduct theoretical and practical research on collegiate mathematics teaching and learning, or develop and evaluate college mathematics curriculum.

## AM Core Requirements (18 credit hours)

- MATH 500 Applied Analysis I
- MATH 553 Discrete Applied Mathematics I
- MATH 577 Computational Mathematics I
- MATH 515 Ordinary Differential Equations and Dynamical Systems MATH 532 Linear Algebra
- MATH 476 Statistics

## MSED Core Requirements (18 credit hours)

MSED 598	Methods of College Teaching in Mathematics
	and Science
MSED 599	College Teaching Practicum in Mathematics
	and Science
MSED 601	Critical Analysis in Quantitative Research
MSED 602	Quantitative Research Design and
	Practicum
MCED CO2	Ouities 1 Anologie in Oueliteting Descende

- MSED 603 Critical Analysis in Qualitative Research
- MSED 604 Qualitative Research Design and Practicum

### AM Electives (minimum of 12 credit hours)

MATH 401 Analysis II MATH 402 Complex Analysis MATH 420 Geometry MATH 475 Probability MATH 5xy (any 500-level AM courses)

# MSED Electives (minimum of 9 credit hours)

- MSED 501 Advanced Strategies: Mathematics
- MSED 550 Clinical Supervision in Science/Mathematics
- MSED 552 Assessment and Evaluation
- MSED 555 Mathematics Curriculum
- MSED 571 Problem Solving and Nature of Mathematics

The qualifying exam is fulfilled by achieving better than a 3.5/4.0 GPA on the MATH 476, MATH 500, MATH

553, and MATH 577 AM core courses and a 3.5/4.0 GPA on the MSED 601, MSED 602, MSED 603, and MSED 604 MSED core courses and passing an oral examination within the first five semesters of Ph.D. study. The oral exam consists of two one-hour parts covering AM and MSED core courses respectively. For the AM part, the candidate selects any two out of the four above-mentioned AM core courses plus another AM core course to be tested on during the oral exam. For the MSED part, the candidate proposes five position statements ranked by the faculty. The MSED oral exam is composed of the two position statements with the highest rankings. Position Statement 1: Written defense to support position with empirical research. Position Statement 2: Oral defense.

The comprehensive exam consists of an oral examination based on the student's research proposal. The exam aims to ensure that the student has the background to carry out successful research in his/her chosen area and the proposed research has sufficient scholarly merit.

A minimum of 25 hours should be devoted to thesis research (CMED 691). The dissertation is expected to contain a distinct and substantial, original and publishable contribution to the field of study. An oral examination in defense of the thesis constitutes completion of the degree.

(*) 32 credits maximum transfer from master's coursework; 42 maximum transfer of graduate coursework credits; the number of subjects allowed for transfer credit depends on what subject have been recently taken and is decided on a case-by-case basis

**Admission Criteria:** Admission to the joint Ph.D. program in collegiate mathematics education requires:

- A master's or bachelor's Degree in mathematics or applied mathematics. Candidates whose degree is in another related field (such as, computer science, physics, or engineering) and whose background in mathematics is strong are also eligible for admission and are encouraged to apply.
- GRE score 1100 (quantitative and verbal), 3.0 (analytical)
- TOEFL (minimum score of 600 for paper-based, 250 for computer-based, and 100 for internet-based test) if from non-English speaking country
- A minimum GPA of 3.0/4.0 is required
- Professional statement of goals/objectives (2 pages)
- Vita
- Three letters of recommendation
- An interview may be required

# **Course Descriptions**

Numbers in parentheses indicate class, lab and total credit hours, respectively.

### **MSED 500**

## Analysis of Classrooms II (Practicum & Seminar)

This course includes a two-hour seminar on campus each week along with approximately five hours per week in an area school. This is an introductory course that provides students background learning theory, classroom management, aspects of effective teaching, critical classroom variables, and the school as a system.

(3-0-3)

# **MSED 501**

### Advanced Stategies: Math

A course that provides additional exposure and development of instructional strategies and models of mathematics teaching. Special emphasis is placed upon promoting critical thinking and decision making.

# (3-0-3)

# **MSED 502**

### Advanced Strategies:Science

A course that provides additional exposure and development of instructional strategies and models of science teaching. Special emphasis is placed upon promoting critical thinking and decision making.

(3-0-3)

### **MSED 509**

### Instructional Strategies for Middle School Mathematics

This course addresses concerns of teaching grades 5 through 8 math by considering the social and psychological characteristics of students in transition from elementary to high school mathematics. The course uses a focus on rational number and reasoning (topics that span middle school curriculum) to study students' development of powerful representational systems and conceptual flexibility. Participants will learn about building mathematical community in which students construct mathematical evidence for claims of perceived regularities and patterns on logical reasoning and mathematical thinking. Participants will select, adapt, and design math tasks to serve instructional purposes and will learn what it means to build an ongoing assessment system that integrates self, peer, teacher, and formative/summative assessment into best practice. (3-0-3)

### **MSED 510**

### **Problem Based Algebra**

Algebra is taught via a problem solving approach with connections to other topic areas such as geometry, statistics and probability. Explorations with and conjecturing about number relationships and functions provide experiences from which students develop algebraic habits of mind: Doing and undoing (algebraic thinking that involves reflective or reverse algebraic reasoning, doing problems and organizing data to representation situations in which input is related to output by well-defined functional rules); and abstracting from computation (developing the capacity to think about computations independently of particular numbers used). Instructor permission required.

(3-0-3)

## **MSED 511**

### Problem Based Number Theory

Number theory is taught via a problem solving approach with connections to geometry, logic, and probability. Explorations with and conjecturing about number patterns provide experiences from which students study various topics including the following: factors, primes, and prime factorization; counting techniques; greatest common factor (GCF) and least common multiple (LCM); divisibility; number patterns (e.g., Pascal's triangle, polygonal numbers, Pythagorean triples, Fibonacci numbers); Diophantine equations; remainder classes and modular arithmetic; iteration, recursion, and mathematical induction. Basic algebra and instructor permission required. (3-0-3)

## **MSED 512**

# Philosophy of Science: Key Topics & Applications to K-12 Science Education

This course presents fundamental topics and key issues from philosophy of science (e.g., explanation, representation/models, evidence, laws and causation, confirmation/inductive logic, etc.). The goal of the course is to enrich teachers' understanding of philosophy of science so that they will be better prepared to design instructions both about science content and about NOS and NOSI. To achieve this, each course is explicitly linked to particular subject matter and concepts and/or NOS or NOSI ideas. Teachers will be facilitated to see why and how philosophy of science can inform science instruction. (3-0-3)

### **MSED 513**

### **Problem Based Statistics & Probability**

This course emphasizes statistics and probability as practical subjects devoted to obtaining and processing data with a view toward making statements that often extend beyond the data. These statements (i.e., inferences) take the form of estimates, confidence intervals, significance tests, etc. The content of this course is concerned with the production of good data, and involves consideration of experimental designs and sample surveys. The activities have their origin in real data and are concerned with processing the data in the widest contexts and with a wide variety of applications such as social, administrative, medical, the physical sciences and the biological sciences. Basic Algebra and Instructor permission required. (3-0-3)

### MSED 514

### **Problem-Based Geometry**

Geometry is taught via problem solving with connections to other topic areas such as algebra and number theory. Explorations of and conjecturing about fundamental concepts of Euclidean geometry in two and three dimensions and their application provide experiences from which students study various topics including the following: properties and relationships of geometric objects; geometric proof; area and volume; transformations, symmetry, and tessellations; trigonometric ratios; and visual modeling of algebraic operations as well as algebraic abstract concepts. (3-0-3)

## **MSED 515**

### Physical Science Research Practicum I

The purpose of this course is to provide a comprehensive, immerse experience in scientific research for current and perspective K-12 science teachers. It is intended as the first in a two course sequence. In this course, students will begin by having a module covering key concepts in the sociology of science. The bulk of student work will be to participate in a laboratory placement.  $p_{\ell}$  Prerequisite: Admission into Physical Science Initiative Cohort program, or approval of the instructor.jbr / $i_{\ell}$  (0-0-3)

# MSED 516

### Physical Science Research Practicum II

The purpose of this course is to provide a comprehensive, immerse experience in scientific research for current and prospective K-12 science teachers. It is intended as the second in a two-course sequence. In this course, students will focus on making connections between the content of their research setting and the K-12 curriculum. The bulk of student work will be to participate in a laboratory placement. (0-0-3)

## MSED 517

### **Problem-Based Calculus**

This course is focused on the development of foundational ideas, concepts, and methods of introductory calculus and its basic applications with emphasis on various problemsolving strategies, visualization, mathematical modeling, and connections to algebra, geometry, number theory, and logic relevant to the middle school mathematics curriculum. Explorations with the SimCalc software and conjecturing about linking graphs, tables, and concrete to represent dynamic situations provide experiences from which students study various topics including the following: linear, quadratic, cubic, exponential, logarithmic, and trigonometric functions and their graphs; limits and continuity; rate of change, slope, tangent, and derivative; area under a curve and integration; and elements of infinite series.

Prerequisite(s): [(MSED 320) OR (MSED 514) OR (MSED 520)] AND [(MSED 510)] (3-0-3)

# MSED 518

# History of Science: Key Episodes and Topics and Applications to K-12 Science Education

The course presents fundamental topics and key issues from history of science (the organization of science, science and religion, science and technology, scientific revolutions, etc. The goal of the course is to enrich teachers' understanding of history of science so that they will be better prepared to design instructions both about science content and about NOS and NOSI. To achieve this, each course is explicitly linked to particular subject matter and conceptsand/or NOS or NOSI ideas. Teachers will be facilitated to see why and how history of science can inform science insturction. (3-0-3)

## **MSED 520**

### Geometry

The course is focused on selected topics related to fundamental concepts and methods of Euclidean geometry in two and three dimensions and their applications with emphasis on various problem-solving strategies, geometric proof, visualization, and interrelation of different areas of mathematics. Instructor permission required.

(3-0-3)

## MSED 521

### Perspectives in Analysis

This course is focused on selected topics related to fundamental concepts and methods of classic analysis and their applications with emphasis on various problemsolving strategies, visualization, mathematical modeling, and interrelation of different areas of mathematics. Instructor permission required. (3-0-3)

## **MSED 523**

## Expedition Green – Environmental Science

The course is designed to prepare teachers to teach environmental processes and systems, an understanding of environmental issues, personal and civic responsibility, and critical thinking skills. Teachers will increase their knowledge of ecology, ecosystems, resource management, and sustainability. Each class explores how these environmental science topics can be brought back into the classroom using a variety of pedagogical skills and engaging activities. The Expedition Green course models the use of inquiry based, hands-on teaching methods as well as the multiple ways that an informal institution, such as the Museum of Science and Industry, can be used to enhance school curricula. This course meets during the academic year, six sessions, 8:00 a.m. to 3:00 p.m. (3-3-3)

## MSED 524

### Get Energized – Physical Science

Get Energized is designed to help teachers become more proficient in key physical science concepts related to energy. Teachers can increase their comfort level in teaching energy related topics such as light, mechanical, heat, sound, and electrical. Each full-day workshop focuses on a particular energy topic and explores how that topic can be brought back to the classroom in an engaging way. This program also explores how to further the interaction of inquirybased teaching methods into the classroom as well as the multiple ways that an informal institution can be used to further the curriculum objectives established. Major topics include energy transformation, potential and kinetic energy, mechanical energy, electrical energy, sound, and thermal. The course meets during the academic year, six sessions, 8:00 a.m. to 3:00 p.m. (3-3-3)

### MSED 525

### All About You – Life Science

All About You focuses on life science, particularly the science of the human body. The teacher professional development series is designed to help teachers learn to utilize inquirybased and hands-on/minds-on science curriculum both within and outside of the classroom setting. Through this intensive and engaging year-long program, the workshops focus on expanding science teachers' capacity by building their content knowledge and enhancing their instructional practice. Aside from this program being broad based and interdisciplinary. this program explores how to further the interaction of inquiry-based teaching methods into the classroom as well as the multiple ways that an informal institution, such as the Museum of Science and Industry, can be used to further the curriculum objectives established. Major topics include cells, tissues and organs, genetics and evolution, body systems, health and wellness. The course meets during the academic year, six sessions, 8:00 a.m. to 3:00 p.m. (3-3-3)

### **MSED 526**

# Great Lakes Rock – Earth Science

In Great Lakes Rock, late elementary and middle school teachers will increase their knowledge of earth systems science concepts and principles, especially those related to climate change and phenomena in the Great Lakes region. Teachers will discuss science content and practice inquiry-based classroom activities that address the following key topics: earth systems; great lakes ecosystems; and life and the environment. (3-3-3)

# MSED 530

## Teacher Education/Professional Development in Science

A course that stresses the empirical research on best practices in teacher education and professional development in science. (3-0-3)

### **MSED 531**

**Teacher Education/Professional Development in Mathematics** A course that stresses the empirical research on best practices in teacher education and professional development in mathematics. (3-0-3)

# MSED 533

### **Expedition Green – Environmental Science**

The course is designed to prepare teachers to teach environmental processes and systems, an understanding of environmental issues, personal and civic responsibility, and critical thinking skills. Teachers will increase their knowledge of ecology, ecosystems, resource management, and sustainability. Each class explores how these environmental science topics can be brought back into the classroom using a variety of pedagogical skills and engaging activities. The Expedition Green course models the use of inquiry based, hands-on teaching methods as well as the multiple ways that an informal institution, such as the Museum of Science and Industry, can be used to enhance school curricula. This course is a continuation of MSED 523.

### (3-0-3)

### **MSED 534**

### Get Energized – Physical Science

Get Energized is designed to help teachers become more proficient in key physical science concepts related to energy. Teachers can increase their comfort level in teaching energy related topics such as light, mechanical, heat, sound, and electrical. Each full-day workshop focuses on a particular energy topic and explores how that topic can be brought back to the classroom in an engaging way. This program also explores how to further the interaction of inquirybased teaching methods into the classroom as well as the multiple ways that an informal institution can be used to further the curriculum objectives established. Major topics include energy transformation, potential and kinetic energy, mechanical energy, electrical energy, sound, and thermal. This course is a continuation of MSED 524. (3-0-3) MSED 535 All About You – Life Science

### All About You focuses on life science, particularly the science of the human body. The teacher professional development series is designed to help teachers learn to utilize inquirybased and hands-on/minds-on science curriculum both within and outside of the classroom setting. Through this intensive and engaging year-long program, the workshops focus on expanding science teachers' capacity by building their content knowledge and enhancing their instructional practice. Aside from this program being broad based and interdisciplinary, this program explores how to further the interaction of inquiry-based teaching methods into the classroom as well as the multiple ways that an informal institution, such as the Museum of Science and Industry, can be used to further the curriculum objectives established. Major topics include cells, tissues and organs, genetics and evolution, body systems, health and wellness. This course is a continuation of MSED 525.

(3-0-3)

### **MSED 536**

### Great Lakes Rock - Earth Science

In Great Lakes Rock, late elementary and middle school teachers will increase their knowledge of earth systems science concepts and principles, especially those related to climate change and phenomena in the Great Lakes region. Teachers will discuss science content and practice inquiry-based classroom activities that address the following key topics: earth systems; great lakes ecosystems; and life and the environment. This course is a continuation of MSED 526. (3-0-3)

### **MSED 538**

#### Inquiry & Problem Solving

A group of authentic inquiry experiences supervised by practicing scientists or mathematicians. (3-0-3)

### **MSED 540**

#### Informal Education Practicum

Placement in an informal educational setting such as museums and outdoor education. The focus of this course is on the use of informal setting to supplement classroom instruction. (3-0-3)

### MSED 542

#### Energy & Forces

This course is the first in a three-course sequence designed to cover physical science content for middle grade teachers. The underlying theme for the course is the concept of energy. The course will follow a strategy of introducing fundamental principles, and then covering further material as applications of those principles. The course will address energy, forces and interactions, momentum, materials and phases of matter. Students will explore a variety of scenarios involving these principles to develop their abilities to apply physics concepts to novel situations.  $p_{\ell}Prerequisite:$  Admission to the Physical Science Initiative Cohort program, or approval of the instructor.jbr  $/\ell_{\ell}$ 

(3-0-3)

### MSED 543 The Atomic World

### This course is the second in a three course sequence designed to cover physical science content for middle grades teachers. The underlying theme for the course is phenomena at the atomic scale. The course will follow a strategy of introducing broad, basic principles, and then covering further material as applications of those principles. The course will address issues of scale, historical model of matter, Heisenberg Uncertainty Principle, Young Double Slit Experiment, models of light, and reaction energies. Students will explore a variety of scenarios involving these principles to develop their abilities to apply physics concepts to novel situations.

(3-0-3)

## MSED 544

## **Physical Science Applications**

This course is the third in a three-course sequence designed to cover physical science content for middle grade teachers. The underlying themes for the course are motion, astronomy, and earth science. The course will follow a strategy of applying the broad, basic principles covered in the previous two courses to new situations. The course will address the investigation of physical science content related to the nature of motion, astronomy, and earth science. Students will explore a variety of scenarios involving these principles to develop their abilities to apply physics concepts to novel situations.

(3-0-3)

## MSED 545

## Statistics for Educators I

Part one of a two-part course. The course provides concepts and methods of gathering, describing and drawing conclusions from data. Statistical reasoning, probability, sampling, regression, correlation, forecasting, nonparametric statistics, conceptions and misconceptions about statistics, problem solving techniques and current research are included throughout the course.

(3-0-3)

## MSED 546

### Statistics for Educators II

Part two of a two-part course. Statistical reasoning, probability, sampling, regression, correlation, forecasting, nonparametric statistics, conceptions and misconceptions about statistics, problem solving techniques and current research are included throughout the course. (3-0-3)

## MSED 547

### **Physical Science Instrumentation Methods**

This course is designed to explore investigation and experimentation methods in the physical sciences for middle grade teachers. The course will follow a strategy of introducing devices or tools used in experimentation and then designing and running fundamental experiments using these tools.

(3-0-3)

# **MSED 550**

## **Clinical Supervision in Science/Mathematics**

Provides for the development of a variety of classroom observation techniques and clinical supervision skills. (3-0-3)

## MSED 552

### Assessment & Evaluation

Contemporary assessment and evaluation theory and the development of valid cognitive, affective, and psychomotor assessment items/tasks. In-depth attention is given to the development and scoring of alternative assessment techniques such as portfolios and projects. (3-0-3)

### **MSED 554**

## Middle & Secondary Level Science Curriculum

This course will develop a functional understanding of various factors that influence the development and direction of middle and secondary science curricula. Students will become familiar with strategies to integrate language arts, reading, and writing in the content area of science. Students will apply knowledge of subject matter, curriculum development, and curriculum theory to construct a hypothetical curriculum. Current trends, history of these trends, and rationales for science curriculum reform will be examined. (3-0-3)

# MSED 555

# Middle & Secondary Level Mathematics Curriculum

This course will develop a functional understanding of various factors that influence the development and direction of middle and secondary mathematics curricula. Students will become familiar with strategies to integrate language arts, reading, and writing in the content area of mathematics. Students will apply knowledge of subject matter, curriculum development, and curriculum theory to construct a hypothetical curriculum. Current trends, history of these trends, and rationales for mathematics curriculum reform will be examined. (3-0-3)

### **MSED 560**

## Research & Evaluation

Analysis of qualitative and quantitative empirical research in science and mathematics education. (3-0-3)

# **MSED 562**

# Action Research I

Reviewing, designing, and conducting research studies within the context of the students' own teaching. (Credit: Variable)

# MSED 563

### Action Research II

Reviewing, designing, and conducting research studies within the context of the students' own teaching. This course is a continuation of MSED 562. (0-0-3)

## MSED 564

### Action Research III

Reviewing, designing, and conducting research studies within the context of the students' own teaching. This course is a continuation of MSED 562 and MSED 563. (0-0-3)

## MSED 570

### Inquiry & Nature of Science

Developing a functional understanding of nature of science in the context of scientific inquiry. (3-0-3)

### MSED 571

### **Problem Solving & Nature of Mathematics**

Developing a functional understanding of nature of mathematics in the context of problem solving. (3-0-3)

# **MSED 573**

### Expedition Green – Environmental Science

The course is designed to prepare teachers to teach environmental processes and systems, an understanding of environmental issues, personal and civic responsibility, and critical thinking skills. Teachers will increase their knowledge of ecology, ecosystems, resource management, and sustainability. Each class explores how these environmental science topics can be brought back into the classroom using a variety of pedagogical skills and engaging activities. The Expedition Green course models the use of inquiry based, hands-on teaching methods as well as the multiple ways that an informal institution, such as the Museum of Science and Industry, can be used to enhance school curricula. This course is condensed and offered in the summer semester only. (1.5-1.5-3)

### **MSED 574**

## Physical Science – Get Energized

Get Energized is designed to help teachers become more proficient in key physical science concepts related to energy. Teachers can increase their comfort level in teaching energy related topics such as light, mechanical, heat, sound, and electrical. Each full-day workshop focuses on a particular energy topic and explores how that topic can be brought back to the classroom in an engaging way. This program also explores how to further the interaction of inquirybased teaching methods into the classroom as well as the multiple ways that an informal institution can be used to further the curriculum objectives established. Major topics include energy transformation, potential and kinetic energy, mechanical energy, electrical energy, sound, and thermal. This course is condensed, offered summer semester only. (1.5-1.5-3)

### **MSED 575**

#### All About You – Life Science

All About You focuses on life science, particularly the science of the human body. The teacher professional development series is designed to help teachers learn to utilize inquirybased and hands-on/minds-on science curriculum both within and outside of the classroom setting. Through this intensive and engaging year-long program, the workshops focus on expanding science teachers' capacity by building their content knowledge and enhancing their instructional practice. Aside from this program being broad based and interdisciplinary, this program explores how to further the interaction of inquiry-based teaching methods into the classroom as well as the multiple ways that an informal institution, such as the Museum of Science and Industry, can be used to further the curriculum objectives established. Major topics include cells, tissues and organs, genetics and evolution, body systems, health and wellness. This course is condensed, offered summer semester only.

(1.5 - 1.5 - 3)

# **MSED 576**

## Earth Science – Great Lakes Rock

In Great Lakes Rock, late elementary and middle school teachers will increase their knowledge of earth systems science concepts and principles, especially those related to climate change and phenomena in the Great Lakes region. Teachers will discuss science content and practice inquiry-based classroom activities that address the following key topics: earth systems; great lakes ecosystems; and life and the environment.

(3-0-3)

## MSED 580

### Adolescent Psychology

This course is designed to develop the participants' The main foci understanding of adolescent psychology. throughout the course are the unique aspects of adolescents and how those aspects influence behavior, learning, and social interactions, especially with regard to middle schools. Studies will include educational psychology theories and models, motivation and learning, developmental changes during adolescence, cognitive abilities, human ecology, diversity, and cultures. Additionally, participants will examine historical and philosophical perspectives of adolescent psychology and synthesize how these perspectives have influenced teaching, learning, and cultures in middle schools. The course will involve weekly readings and reflections, classroom experiences, short assignments, tests/quizzes, research projects, and formal class presentations. Requires admission into the secondary mathematics teacher certification program or instructor permission.

(3-0-3)

#### **MSED 583**

### Inquiry, Content & Nature of Science

This course is appropriate for continuing education of secondary education science teachers, who will be engaged in authentic scientific inquiry with practicing research scientists, learning about nature of science, scientific inquiry, and subject matter, and developing pedagogical knowledge and skills related to these concepts. The goal of the Project ICAN is to empower teachers to help their students to work toward scientific inquiry. (Variable:1-3) (Credit: Variable)

### MSED 584

#### Inquiry, Context, Nature & Science

Understanding nature of science as it relates to subject matter, and developing pedagogical knowledge and skills related to these concepts. (3-0-3)

### **MSED 591**

### Research & Thesis M.S.

A course that provides the guidance and opportunity for authentic research projects in Science or Mathematics Education to fulfill thesis requirements for MS Candidates. (Credit: Variable)

## MSED 594

### Special Projects

Advanced projects involving independent study, and especially fieldwork and modeling projects. (Variable: 1-6) (Credit: Variable)

### MSED 597

### Special Problems

Current problems in science/mathematics education. May be repeated for credit with different topics. (Credit: Variable)

#### **MSED 598**

### Methods of College Teaching in Mathematics & Science

The course is designed to allow each student to develop the theoretical background, practical knowledge, and skills for successful college level mathematics or science teaching. Specific emphasis will be placed upon instructional methods/models, curriculum development, and instructional planning. (3-0-3)

## MSED 599

## **College Teaching Practicum**

The purpose of the course is to enhance college level teacher preparation with an advanced learning experience joining together theory and practice. This course provides the student the opportunity to practice and improve knowledge and skills at teaching. The student may actively participate or act as an observer at a different college. In addition, students are required to prepare a Portfolio. The Portfolio provides the student an opportunity to demonstrate a readiness for teaching that describes their efforts and progress in preparing to teach science or mathematics at the college level.

(3-0-3)

### **MSED 601**

### Critical Analysis in Quantitative Research

A study of quantitative research designs and analytical procedures with critical analysis of perspectives of research in science/mathematics education. (2.0.2)

(3-0-3)

# **MSED 602**

### Quantitative Research Design & Practicum

A study of quantitative research designs, analytical procedures, and in-depth analysis with specific applications in science/mathematics education. (3-0-3)

(3-0-3)

## MSED 603

### **Qualitative Research Critical Analysis**

A study of qualitative research designs and analytical procedures with critical analysis of perspectives of research in science/mathematics education. (3-0-3)

### **MSED 604**

### Qualitative Research Design & Praticum

A study of qualitative research designs, analytical procedures, and in-depth analysis with specific applications in science/mathematics education.

(3-0-3)

# MSED 691

Ph.D. Thesis Research

A course that provides the guidance and opportunity for authentic research projects in Science or Mathematics Education to fulfill thesis requirements for PhD Candidates. Instructor permission required. (Credit: Variable)

# Department of Mechanical, Materials, and Aerospace Engineering

243 Engineering 1 Building 10 W. 32nd St. Chicago, IL 60616 312.567.3175 dept@mmae.iit.edu www.mmae.iit.edu

**Chair:** Keith Bowman

Associate Chair:

Kevin Cassel

# **Degrees Offered**

Master of Science in Mechanical and Aerospace Engineering

Master of Science in Materials Science and Engineering Master of Science in Manufacturing Engineering Master of Mechanical and Aerospace Engineering Master of Materials Science and Engineering

# **Interdisciplinary Program**

Master of Science in Mechanical and Aerospace Engineering with specialization in Energy/Environment/Economics  $(E^3)$ 

# **Certificate Programs**

Computer Integrated Design and Manufacturing

# **Research Centers**

Fluid Dynamics Research Center (http://fdrc.iit.edu/)

# **Research Facilities**

Mechanical and aerospace engineering laboratories include the Fejer Unsteady Wind Tunnel; the Morkovin Low-Turbulence Wind Tunnel; the National Diagnostic Facility, a computer-controlled, high-speed, subsonic flow wind tunnel; a high-speed jet facility for aeroacoustic research; a hydrodynamics laboratory; flow visualization systems; laser-based measuring equipment and manufacturing; several computer-based data acquisition, processing and display systems of the Fluid Dynamics Research Center; laboratories in experimental mechanics; laboratories for research in robotics, guidance and navigation, computer integrated manufacturing, Footlik CAD lab, biomechanics and its instrumentation, comThe Department of Mechanical, Materials, and Aerospace Engineering offers several flexible programs in mechanical and aerospace engineering, with five major areas of study: computer-aided design and manufacturing, dynamics and control, fluid dynamics, solids and structures, and thermal sciences. The department also offers programs in materials science and engineering and manufacturing engineering.

Master of Manufacturing Engineering Doctor of Philosophy in Mechanical and Aerospace Engineering Doctor of Philosophy in Materials Science and Engineering

Master of Mechanical and Aerospace Engineering with specialization in Energy/Environment/Economics  $(E^3)$ 

Product Quality and Reliability Assurance

Thermal Processing Technology Center (http://tptc.iit.edu/)

bustion, internal combustion engines, two-phase flow and heat-transfer, electrohydrodynamics, and combined heat and mass transfer; and research facilities for atomization, spray flames, and emissions from mobile and stationary combustion sources.

Materials science and engineering laboratories include facilities for research in metallography, heat treatment, and mechanical testing; optical, scanning, and transmission electron microscopes; powder metallurgy, and laser machining facilities. The department has numerous computers and workstations available for computational research activities.

# **Research Areas**

The faculty conducts research activities in fluid dynamics, including aeroacoustics, flow control, turbulent flows, unsteady and separated flows, instabilities and transition, turbulence modeling, flow visualization techniques, computational fluid dynamics; metallurgical and materials engineering, including microstructural characterization, physical metallurgy of ferrous and nonferrous alloys, powder materials, laser processing and machining, high temperature structural materials, mechanical behavior, fatigue and fracture, environmental fatigue and fracture, computational x-ray diffraction analysis, texture, recrystallization and computational methods in materials processing; solids and structures, including experimental mechanics of composites and cellular solids, high strain rate constitutive modeling and thermomechanical coupling, fracture mechanics, design and testing of prosthetic devices; computational mechanics, cable dynamics and analysis of inelastic solids; theoretical

# Faculty

Arastoopour, Hamid, Professor of Chemical Engineering and Mechanical Engineering, Henry R. Linden Professor of Engineering, and Director of the Wanger Institute for Sustainability and Energy Research (WISER), . B.S., Abadan Institute of Technology (Iran); M.S., Ph.D., G.E., Illinois Institute of Technology. Computational fluid dynamics (CFD) and transport phenomena of multiphase flow, fluidization, flow in porous media, particle technology and material processing, and environmental engineering problems, hydrogen storage, tire recycling, particle technology in applications to coal gasification, production of gas from unconventional gas reserves and hydrates, and energy sustainability issues.

Bowman, Keith J., Duchossois Leadership Professor of Materials Engineering and Chair, Mechanical, Materials, and Aerospace Engineering. B.S., M.S., Case Western Reserve University; Ph.D., University of Michigan. Mechanical behavior of materials, electromechanical behavior, preferred orientation and property anisotropy, processing of ceramic materials.

Cammino, Roberto, Lecturer of Mechanical and Aerospace Engineering. B.S., M.S., Ph.D., Illinois Institute of Technology. Fracture mechanics, finite element method.

Cassel, Kevin W., Associate Professor of Mechanical and Aerospace Engineering and Associate Chair. B.S., Messiah College; M.S., Ph.D., Lehigh University. Computational fluid dynamics, unsteady boundary-layer flows, buoyancy-driven flows, supersonic and hypersonic boundary-layer flows, and computational hemodynamics.

Cesarone, John C., Senior Lecturer of Mechanical Engineering. B.S., M.S., University of Illinois; Ph.D., Northwestern University. Robotics, reliability engineering and manufacturing.

mechanics, including wave propagation, fracture, elasticity and models for scoliosis; computer added design and manufacturing, concentrated in the areas of computeraided design, computer-based machine tool control, computer graphics in design, manufacturing processes, wear and fracture behavior of cutting tols, tribology, frictional wear characteristics of ceramics, dynamic systems, and mechanical vibrations; thermal sciences, including phase change heat transfer, enhancement of heat transfer and mass transport in macro and micro scales, electrohydrodynamics, spray combustion, atomization, transport processes within gas-liquid and gas-solid dispersions and suspensions, alternative fuels, mobile and stationary source combustion emissions, and dynamics and control, including guidance, navigation, and control of aircraft and spacecraft, intelligent control for aircraft models, flow fields, robotics devices for laser machining; and dynamic analysis and control of complex systems.

Clack, Herek L., Associate Professor of Mechanical and Aerospace Engineering. B.S., Massachusetts Institute of Technology; Ph.D., University of California-Berkeley. Thermofluid systems: atomization, combustion, hazardous waste incineration, combustion emissions, heat/mass transfer and phase change, ultrasound and sonochemical materials processing.

Cramb, Alan W., Professor of Materials Science and Engineering, Provost, and Senior Vice President for Academic Affairs. B.Sc., University of Strathclyde (Scotland); Ph.D., University of Pennsylvania. Initial solidification behavior of steels, solidification behavior of liquid oxides, effect of inclusion chemistry on solidification behavior, clean steel production, initial solidification phenomenain a continuous casting mold.

Datta-Barua, Seebany, Assistant Professor of Mechanical and Aerospace Engineering. B.S., M.S., Ph.D. Stanford University. Satellite-based atmospheric remote sensing, global navigation satellite systems, geospace environment imaging, estimation and monitoring.

Gosz, Michael R., Associate Professor Mechanical and Materials Engineering and Vice Provost for Undergraduate Affairs. B.S., Marquette University; M.S., Ph.D., Northwestern University. Computational solid mechanics, fracture mechanics, interface effects in composite materials, modeling of composite structures subjected to thermal cycling, and nonlinear dynamic finite element analysis of submerged flexible structures.

Kallend, John S., Professor of Materials Engineering and Physics. B.A., M.A., Ph.D., Cambridge University (England). Computational methods of crystallographic texture analysis and properties of polycrystalline aggregates. Khanafseh, Samer, Research Assistant Professor of Mechanical and Aerospace Engineering. B.S., Jordan University of Science and Technology (Jordan); M.S., Ph.D., Illinois Institute of Technology.

Meade, Kevin P., Professor of Mechanical Engineering. B.S., M.S., Illinois Institute of Technology; Ph.D., Northwestern University. Solid mechanics, biomechanics, elasticity, fracture mechanics and computational mechanics.

Nagib, Hassan M., John T. Rettaliata Professor of Mechanical and Aerospace Engineering. B.S., M.S., Ph.D., Illinois Institute of Technology. Fluid dynamics, heat transfer, applied turbulence, wind engineering, and aeroacoustics.

Nair, Sudhakar E., Professor of Mechanical and Aerospace Engineering and Applied Mathematics. B.Sc., Regional Engineering College (India); M.E., Indian Institute of Science (India); Ph.D., University of California-San Diego. Solid mechanics, stress analysis of composite and inelastic material, dynamics of cable, fracture mechanics and wave propagation theory.

Nash, Philip G., Professor of Materials Engineering and Director of the Thermal Processing Technology Center. B.S., City of London Polytechnic (England); Ph.D., Queen Mary College of London University (England). Physical metallurgy, intermetallics, powder metallurgy, composites, phase equilibria and transformations.

Ostrogorsky, Aleksandar, Professor of Mechanical and Materials Engineering. Dipl.Ing., University of Belgrade (Serbia); M.S., Rensselaer Polytechnic Institute; Sc.D., Massachusetts Institute of Technology. Heat and mass transfer phenomena occurring in materials processing; Directional solidification/single crystal growth focusing on semiconductor alloys; Wide band gap materials for gamma ray detectors (semiconductors and scintillators); Diffusion, growth of carbon nanotubes.

Pervan, Boris, Professor of Mechanical and Aerospace Engineering. B.S., University of Notre Dame; M.S., California Institute of Technology; Ph.D., Stanford University. Dynamics, control, guidance, and navigation.

Qian, Xiaoping, Associate Professor of Mechanical and Aerospace Engineering. B.S., M.S. Huazhong University of Science and Technology (China); Ph.D., University of Michigan. 3D object digitization, design and manufacturing, Geometry processing, Shape and topology optimization.

Raman, Ganesh, Associate Professor of Mechanical and Aerospace Engineering and Associate Dean of the Graduate College for Research. B.T., Indian Institute of Technology (India); M.S., Cleveland State University; Ph.D., Case Western Reserve University. Experimental fluid mechanics, aeroacoustics, active flow control, jet screech, and fluidics. Rempfer, Dietmar, Professor of Mechanical and Aerospace Engineering and Applied Mathematics and Associate Dean, Armour College of Engineering. M.S., Ph.D., Universitat Stuttgart (Germany). Fluid mechanics, especially theoretical studies of transitional and turbulent shear flows in open systems, numerical fluid mechanics, modeling for environmental and urban fluid mechanics, coherent structures in turbulent flows, control of transitional and turbulent wall layers, nonlinear dynamical systems.

Ruiz, Francisco, Associate Professor of Mechanical and Aerospace Engineering. B.S.M.E., Universidad Politecnica de Madrid (Spain); M.E., Ph.D., Carnegie-Mellon University. Combustion, atomization, pollution control of engines, fuel economy, alternative fuel, electronic cooling and special cooling.

Shadden, Shawn, Assistant Professor of Mechanical and Aerospace Engineering. B.S., University of Texas-Austin; Ph.D., California Institute of Technology. Dynamical systems theory, transport and mixing, modeling mechanical systems, biological flows.

Shaw, Leon L., Rowe Family Professor of Materials Science and Engineering. B.S., M.Eng., Fuzhou University (China); M.S., Ph.D., University of Florida. Materials synthesis and processing, energy storage and conversion, solid freeform fabrication.

Spenko, Matthew, Assistant Professor of Mechanical Engineering. B.S. Northwestern University; M.S., Ph.D., Massachusetts Institute of Technology. Robotics, design, dynamics, and control.

Tin, Sammy, Associate Professor of Materials Engineering. B.S., California Polytechnic State University-San Luis Obispo; M.S., Carnegie Mellon University; Ph.D., University of Michigan. Processing and deformation characteristics of high-temperature structural materials, modeling the microstructure of Ni-base superalloy turbine disks during thermomechanical processing, understanding the mechanisms of creep and fatigue deformation in advanced high-refractory content single crystal turbine blades.

Vural, Murat, Associate Professor of Mechanical and Aerospace Engineering. B.Sc., M.Sc., Ph.D., Istanbul Technical University (Turkey). Experimental solid mechanics with emphasis on high-strain-rate mechanical response, thermomechanical coupling, failure characterization and constitutive modeling of homogeneous and heterogeneous materials.

Wark, Candace E., Professor of Mechanical and Aerospace Engineering. B.S., M.S., Michigan State University; Ph.D., Illinois Institute of Technology. Fluid dynamics, turbulence, digital data acquisition and processing. Williams, David R., Professor of Mechanical and Aerospace Engineering and Director of the Fluid Dynamics Research Center. B.S.E., Stevens Institute of Technology; M.S.E., Ph.D., Princeton University. Experimental fluid mechanics with emphasis on flow measurement and flow control techniques.

Wu, Benxin, Associate Professor of Mechanical Engineering. B.S., Tsinghua University; M.S., University of Missouri-Rolla; Ph.D., Purdue University. Lasermatter interactions, laser applications in manufacturing, materials processing, and other areas.

# **Research Faculty**

Benedyk, Joseph C., Research Professor. B.S., M.S., Illinois Institute of Technology; Ph.D., Case Western Reserve University. Metals and materials processing research and development and product development.

Frankfurt, Vladimir, Research Professor.

Hu, Zhiyong, Research Assistant Professor. B.S. Tianjin University, MS. PhD Institute of Metal Research, Chinese Academy of Sciences. Modeling the material processing (casting, extrusion, carburization, heat treatment), predicting the defects, temperature, stress and strain distribution in materials, optimizing the process parameters. Mansy, Hansen, Research Associate Professor. B.S., M.S., Cairo University (Egypt); Ph.D., Illinois Institute of Technology. Biomedical acoustics, non-invasive measurement methods, biomedical fluid dynamics, flow-induced oscillations.

Sciammarella, Cesar A., Research Professor. Dipl.Eng. C.E., Buenos Aires University (Argentina); Ph.D., Illinois Institute of Technology. Experimental mechanics of solids with particular emphasis on optics applied to mechanics of materials and stress analysis and fracture mechanics.

# **Admission Requirements**

Cumulative minimum undergraduate GPA: 3.0/4.0 GRE score minimum: 1000 (quantitative + verbal) 3.0 (analytical writing) Typical admitted quantitative score is 650 minimum. TOEFL minimum: 550/213/80*

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 associate chair for graduate programs serves as a temporary advisor 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 advisor. Students are responsible for following the departmental procedures for graduate study. A guide to graduate study in the department is available on the departmental Web site (http://www.iit.edu/engineering/mmae) and in the MMAE main office (243 Engineering 1) to all registered MMAE graduate students, and should be consulted regularly for information on procedures, deadlines, forms, and examinations. Departmental seminars and colloquia are conducted on a regular basis. All full-time graduate students must register for the MMAE 593 seminar course each semester and attend them regularly.

The department reserves the right to review and approve or deny the application for admission of any prospective degree-seeking student. Non-degree graduate students who intend to seek a graduate degree from the department must maintain a GPA of 3.0 and must apply for admission as a degree-seeking student prior to the completion of 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.

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

# Master of Mechanical and Aerospace Engineering Master of Materials Science and Engineering Master of Manufacturing Engineering

30 credit hours

These programs are 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 programs are course-only degree programs and require a minimum of 30 credit hours. There is no thesis or comprehensive examination requirement. The student, in consultation with his or her advisor, prepares a program of study that reflects individual needs and interests. The advisor, as well as the department's Graduate Studies Committee, the Department Chair, and the Graduate College must approve this program. Students working toward this degree are not eligible for departmental financial support.

# Course Requirements for the Master of Mechanical and Aerospace Engineering

### **Required Courses:**

MMAE 501 Engineering Analysis I

 $\mathbf{AND}$  one core course in major area of study

## AND one of the following:

MMAE 451	Finite Element Methods I
$\rm MMAE\;502$	Engineering Analysis II
$\rm MMAE\;517$	Computational Fluid Dynamics
$\rm MMAE\;532$	Finite Element Methods II
$\rm MMAE\;538$	Computational Techniques in FEM
$\rm MMAE\;544$	Design Optimization
OR	
$\rm MMAE\;570$	Computational Methods in Materials
	Processing

**AND** elective courses as needed.

# Core courses as determined by major area of study Fluid Dynamics

MMAE 510 Fundamentals of Fluid Mechanics

# Thermal Sciences

MMAE 525 Fundamentals of Heat Transfer

## Solids and Structures

MMAE 530 Advanced Mechanics of Solids

### **Dynamics and Controls**

MMAE 541 Advanced Dynamics

### **Computer Aided Design and Manufacturing:**

MMAE 545 Advanced CAD/CAM

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.

# Course Requirements for the Master of Materials Science and Engineering

<b>Required Courses</b>	(for	all	students	not	specializing in
ferrous metallurgy	)				

MMAE 563 Advanced Mechanical Metallurgy MMAE 569 Advanced Physical Metallurgy **AND** MMAE 468 Introduction to Ceramic Materials **OR** MMAE 486 Properties of Ceramics

## AND one of the following:

MMAE 470 Introduction to Polymer Science MMAE 579 Characterization of Polymers **OR** MMAE 580 Structure and Properties Polymers Required Courses (for students specializing in ferrous metallurgy) MMAE 563 Advanced Mechanical Metallurgy

MMAE 569 Advanced Physical Metallurgy MMAE 574 Ferrous Transformations MMAE 575 Ferrous Products: Metallurgy and Manufacture MMAE 578 Fiber Composite Materials

To complete the degree requirements, students may choose from a list of courses and may apply up to twelve 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

# Course Requirements for Master of Manufacturing Engineering

# Mechanical and Aerospace Engineering Emphasis Required Courses

MMAE 545	Advanced CAD/CAM
MMAE 546	Advanced Manufacturing Engineering
MMAE 547	Computer Integrated Manufacturing
	Technologies
OR	
MMAE 557	Computer Integrated Manufacturing Systems
$\mathbf{MMAE}\ 560$	Statistical Process and Quality Control

 $\mathbf{AND}$  one course in materials science and engineering

# AND one course emphasizing numerical methods:

- MMAE 451 Finite Element Methods I
- MMAE 517 Computational Fluid Dynamics
- MMAE 532 Finite Element Methods II
- MMAE 538 Computational Techniques in FEM
- MMAE 544 Design Optimization

### OR

MMAE 570 Computational Methods in Materials Processing

**AND** elective courses as needed.

# Materials Science and Engineering Emphasis Required Courses

MMAE 547 Computer Integrated Manufacturing Technologies MMAE 560 Statistical Process and Quality Control

# AND one of the following:

MMAE 445 CAD/CAM with Numerical Control MMAE 545 Advanced CAD/CAM MMAE 546 Advanced Manufacturing Engineering **OR** MMAE 576 Materials and Process Selection

# AND one of the following:

MMAE 475 Powder Metallurgy MMAE 574 Ferrous Transformations MMAE 575 Ferrous Products: Metallurgy and Manufacture OR MMAE 585 Engineering Optics and Laser-Based Manufacturing AND one course emphasizing numerical methods: MMAE 451 Finite Element Methods I MMAE 517 Computational Fluid Dynamics MMAE 532 Finite Element Methods II

MMAE 538 Computational Techniques in FEM

MMAE 544 Design Optimization

# OR

MMAE 570 Computational Methods in Materials Processing

**AND** elective courses as needed.

# Master of Manufacturing Engineering via Internet

30 credit hours

The Master of 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 advisor, prepares a program reflecting individual needs and interests. All courses are administered online.

# **Required Courses**

$\mathbf{MMAE}\ 545$	Advanced CAD/CAM
$\mathbf{MMAE}\ 546$	Advanced Manufacturing Engineering
$\mathbf{MMAE}\;560$	Statistical Quality and Process Control

- AND MMAE 547 Computer Integrated Manufacturing
- Technologies

# OR

MMAE 557 Computer Integrated Manufacturing Systems

**AND** one materials course

MMAE 563 Advanced Mechanical Metallurgy

 ${\bf AND}$  one course with emphasis on numerical methods

MMAE 704 Introduction to Finite Element Analysis (2 credit hours)

# AND at least 13 credit hours from:

MMAE 433	Design of Thermal Systems
$\mathbf{MMAE}\;445$	CAD/CAM with Numerical Control
$\mathbf{MMAE}\;474$	Metals Processing
MMAE 481	Introduction to Joining Processes
MMAE 540	Robotics
$\mathbf{MMAE}\;557$	Computer Integrated Manufacturing-
	Systems
MMAE 589	Applications in Reliability Engineering I
MMAE 590	Applications in Reliability Engineering II
MMAE 715	Project Management (2 credit hours)
MMAE 720	Design Assurance (2 credit hours)

# Master of Science in Mechanical and Aerospace Engineering Master of Science in Materials Science and Engineering Master of Science in Manufacturing Engineering

32 credit hours Thesis Oral comprehensive exam

The Master of Science degree program advances knowledge through post-baccalaureate coursework and stateof-the-art research in preparation for careers in industrial research and development. The M.S. degree is also generally acceptable as a prerequisite for study toward the doctorate. In line with the department's approach to its graduate programs, a student has considerable flexibility, in consultation with his or her program advisor, in formulating an M.S. program.

The M.S. in Mechanical and Aerospace Engineering or the M.S. in Materials Science and Engineering requires completion of a minimum of 32 credit hours of approved work, which includes six to eight credit hours of thesis research. Before completion of the first semester of graduate study, full-time students should select an area of specialization and a permanent advisor. Graduate students pursuing the M.S. degree on a part-time basis should select a permanent advisor before registering for their twelfth credit hour. The student, in consultation with the advisor, prepares a program of study that reflects individual needs and interests. The advisor must approve this program, as well as the department's Graduate Studies Committee, the Department Chair, and the Graduate College.

After completion of the thesis, the student is required to pass an oral comprehensive examination on his or her thesis and related topics. The examination committee consists of at least three appropriate faculty members who are nominated by the thesis advisor and appointed by the department's Graduate Studies Committee.

# Course Requirements for the Master of Science in Mechanical and Aerospace Engineering

## Required Courses

MMAE 501 Engineering Analysis I MMAE 502 Engineering Analysis II

AND one core course in major area of study AND 6 or more credit hours of non-core courses in major area

**AND** elective courses as needed.

# Core courses as determined by major area of study Fluid Dynamics

MMAE 510 Fundamentals of Fluid Mechanics

# **Thermal Sciences**

MMAE 525 Fundamentals of Heat Transfer

Solids and Structures

MMAE 530 Advanced Mechanics of Solids

# **Dynamics and Controls**

MMAE 541 Advanced Dynamics

# **Computer Aided Design and Manufacturing**

MMAE 545 Advanced CAD/CAM  $\,$ 

No more than nine credit hours of 400-level courses that were not required for the completion of an undergraduate degree will be accepted as satisfying part of the program. Students with interdisciplinary programs will be given special consideration. Up to six credit hours of accelerated (700-level) courses are allowed.

# Course Requirements for the Master of Science in Materials Science and Engineering

# Required Core Courses (12 credit hours)

MMAE 563 Advanced Mechanical Metallurgy MMAE 569 Advanced Physical Metallurgy **AND** MMAE 468 Introduction to Ceramic Materials **OR** MMAE 486 Properties of Ceramics

# AND one of the following:

MMAE 470 Introduction to Polymer Science MMAE 579 Characterization of Polymers **OR** MMAE 580 Structure and Properties of Polymers

**AND** 12-14 hours of non-core courses

Up to 12 credit hours of 400-level, non-core courses that were not required for the completion of an undergraduate degree and approved by the Graduate Studies Committee may count toward satisfying this requirement. Up to six credit hours of accelerated (700-level) courses are allowed.

# Course Requirements for Master of Science in Manufacturing Engineering

# Mechanical and Aerospace Engineering Emphasis Required Courses

MMAE 545 Advanced CAD/CAM MMAE 546 Advanced Manufacturing Engineering MMAE 547 Computer Integrated Manufacturing Technologies

 $\rm MMAE~560~Statistical~Process$  and Quality Control

 $\mathbf{AND}$  one course in materials science and engineering

## AND one course emphasizing numerical methods:

- MMAE 451 Finite Element Methods I
- MMAE 517 Computational Fluid Dynamics
- MMAE 532 Finite Element Methods II
- MMAE 538 Computational Techniques in FEM  $\,$
- MMAE 544 Design Optimization

OR

 $\begin{array}{c} {\rm MMAE~570} \\ {\rm Computational~Methods~in~Materials} \\ {\rm Processing} \end{array}$ 

 ${\bf AND}$  elective courses as needed.

# Materials Science and Engineering Emphasis Required Courses

MMAE 547 Computer Integrated Manufacturing Technologies MMAE 560 Statistical Process and Quality Control

# AND one of the following:

MMAE 445 CAD/CAM with Numerical Control MMAE 545 Advanced CAD/CAM MMAE 546 Advanced Manufacturing Engineering **OR** MMAE 576 Materials and Process Selection

# AND one of the following:

MMAE 475 Powder Metallurgy MMAE 574 Ferrous Transformations MMAE 575 Ferrous Products: Metallurgy and Manufacture OR MMAE 585 Engineering Optics and Laser-Based Manufacturing

# AND one course emphasizing numerical methods:

MMAE 451 Finite Element Methods I MMAE 517 Computational Fluid Dynamics MMAE 532 Finite Element Methods II MMAE 538 Computational Techniques in FEM MMAE 544 Design Optimization **OR** MMAE 570 Computational Methods in Materials Processing

**AND** elective courses as needed.

# Doctor of Philosophy in Mechanical and Aerospace Engineering Doctor of Philosophy in Materials Science and Engineering

84 credit hours beyond the Bachelor of Science Qualifying examination 16 credit hours minimum beyond the M.S. One full year (minimum) of thesis research Comprehensive examination Dissertation and oral defense

This program provides advanced, research-based education and knowledge through advanced coursework, state-of-the-art and original research, and publication of novel results in preparation for careers in academia and industrial research and development.

The department offers programs leading to the Ph.D. in Mechanical and Aerospace Engineering and the Ph.D. in Materials Science and Engineering. The doctoral degree is awarded in recognition of a high level of mastery in one of the several fields of the department including a significant original research contribution. A student working toward the Ph.D. degree has great flexibility in formulating an overall program to meet individual needs under the guidance of an advisor and the department.

Further, the student must be accepted by a thesis advisor 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 advisor, prepares a program of study to meet individual needs and interests, which must then be approved by the advisor, the department's Graduate Studies Committee, the Department Chair, and the Graduate College. The program of study usually consists of at least one full year of advanced coursework beyond the master's degree, or equivalent, and a minimum of one full year of thesis research.

After the student essentially completes all coursework, he or she must pass the Ph.D. comprehensive examination. Conducted by the student's Thesis Advisory Committee, this examination must be completed at least one year prior to graduation.

Concentrated research to satisfy the requirements of a doctoral dissertation is ordinarily conducted after the comprehensive examination has been passed. The dissertation must be approved by the student's Thesis Advisory Committee. Thesis research should be equivalent to at least one full years 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 offcampus research. The doctoral dissertation is expected to contain a distinct and substantial original contribution to the student's field of study. After the research has been completed and a preliminary draft of the dissertation is approved, the candidate defends his or her thesis at a final oral examination, which is open to the public.

# Course Requirements for Mechanical and Aerospace Engineering

## **Required Courses:**

MMAE 501 Engineering Analysis I MMAE 502 Engineering Analysis II

**AND** two courses from group EA (fluid dynamics, thermals sciences and solids and structures students must take MMAE 507 Continuum Mechanics) **AND** one core course in major area of study

**AND** one core course in second area

**AND** 9 or more credit hours of non-core courses in major area

**AND** elective courses as needed.

# Core courses as determined by major area of study Fluid Dynamics

MMAE 510 Fundamentals of Fluid Mechanics

# **Thermal Sciences**

MMAE 525 Fundamentals of Heat Transfer

## Solids and Structures

MMAE 530 Advanced Mechanics of Solids

## **Dynamics and Controls**

MMAE 541 Advanced Dynamics

# Computer Aided Design and Manufacturing

MMAE 545 Advanced CAD/CAM

$\rm MMAE\;503$	Advanced Engineering Analysis
$\rm MMAE\;507$	Introduction to Continuum Mechanics
$\rm MMAE\;508$	Perturbation Methods
MATH $512$	Partial Differential Equations
MATH $515$	Ordinary Differential Equations and
	Dynamical Systems
MATH $522$	Mathematical Modeling
MATH $535$	Optimization I
MATH $544$	Stochastic Dynamics
MATH $545$	Stochastic Partial Differential Equations
MATH $553$	Discrete Applied Mathematics I
ECE 511 A	nalysis of Random Signals
ECE 531 $L$	inear Systems Theory
ECE 537 O	ptimal Feedback Control
ECE 567 St	tatistical Signal Processing

Group EA.

# **Course Requirements for Materials Science and Engineering**

		AND one of the following:
MMAE 501 MMAE 563 MMAE 569 <b>AND</b>	Engineering Analysis I Advanced Mechanical Metallurgy Advanced Physical Metallurgy	MMAE 470 Introduction to Polymer Science MMAE 579 Characterization of Polymers MMAE 580 Structure and Properties of Polymers
MMAE 468 <b>OR</b> MMAE 486	Introduction to Ceramic Materials Properties of Ceramics	<b>AND</b> elective courses as needed.

# **Certificate Programs**

# **Computer Integrated Design and Manufacturing**

# Required Courses (choose four)

- MMAE 445 CAD/CAM with Numerical Control
- MMAE 540 Robotics MMAE 545 Advanced CAD/CAM
- MMAE 547 Computer Integrated Manufacturing-Technologies
- MMAE 557 Computer Integrated Manufacturing-Systems

# Product Quality and Reliability Assurance

# **Required Courses**

- $\rm MMAE~560~Statistical$  Quality and Process Control
- MMAE 589 Applications in Reliability Engineering I
- MMAE 590 Applications in Reliability Engineering II
- MMAE 720 Introduction to Design Assurance

# **Course Descriptions**

Numbers in parentheses represent class hours, lab hours, and total credit hours, respectively.

### **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. (3-0-3)

# 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)]

(3-0-3)

## 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)] (3-0-3)

## MMAE 507

### Introduction to Continuum Mechanics

A unified treatment of those topics that are common to solid and fluid continua. General discussion of Cartesian tensors. Deformation, strain, strain invariants, rotation, compatibility conditions. Motion, velocity, deformation. Momentum, moment of momentum, energy, stress. Principles of balance of local momenta, equations of motion. Principles of frame indifference. Constitutive relations for fluids, elastic and plastic solids.

Prerequisite(s): [(MMAE 501*)] An asterisk (*) designates a course which may be taken concurrently. (4-0-4)

### **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)]

(3-0-3)

# **MMAE 510**

## Fundamentals of Fluid Mechanics

Kinematics of fluid motion. Constitutive equations of isotropic viscous compressible fluids. Derivation of Navier-Stokes equations. Lessons from special exact solutions, self-similarity. Admissibility of idealizations and their applications; inviscid, adiabatic, irrotational, incompressible, boundary-layer, quasi one-dimensional, linearized and creeping flows. Vorticity theorems. Unsteady Bernoulli equation. Basic flow solutions. Basic features of turbulent flows.

Prerequisite(s): [(MMAE 501*)] An asterisk (*) designates a course which may be taken concurrently. (4-0-4)

# 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)] (3-0-3)

### **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)] (4-0-4)

### **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)]

(4-0-4)

## MMAE 514

### **Stability of Viscous Flows**

Concept of hydrodynamic stability. Governing equations. Analytical and numerical treatment of eigenvalue problems and variational methods. Inviscid stability of parallel flows and spiral flows. Thermal instability and its consequences. Stability of channel flows, layered fluid flows, jets and flows around cylinders. Other effects and its consequences; moving frames, compressibility, stratification, hydromagnetics. Nonlinear theory and energy methods. Transition to turbulence.

Prerequisite(s): [(MMAE 502 and MMAE 510)] (4-0-4)

#### MMAE 515 Engineering Aco

# 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. (3-0-3)

### **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. (2-3-3)

## **MMAE 517**

### **Computational Fluid Dynamics**

Classification of partial differential equations. Finitedifference 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 primitivevariables 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)] (3-0-3)

### **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 weightedresiduals approaches, like Galerkin and Galerkin-Tau methods, spectral and pseudospectral methods, and dynamical systems modeling via projections on arbitrary orthogonal function bases. Finite element and spectral element methods will be introduced briefly in the context of Galerkin methods. A subsection of the course will be devoted to numerical turbulence modeling, and to the problem of grid generation for complex geometries.

Prerequisite(s): [(MMAE 501 and MMAE 510)]

# (3-0-3)

### **MMAE 519**

### **Cardiovascular Fluid Mechanics**

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

## **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. (3-0-3)

## **MMAE 522**

### Nuclear, Fossil-Fuel, & 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. (3-0-3)

### **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. (3-0-3)

### **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. (3-0-3)

### **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. (3-0-3)

## **MMAE 526**

### Heat Transfer: Conduction

Fundamental laws of heat conduction. Heat equations and their initial and boundary conditions. Steady, unsteady and periodic states in one or multidimensional problems. Composite materials. Methods of Green's functions, eigenfunction expansions, finite differences, finite element methods.

Prerequisite(s): [(MMAE 502 and MMAE 525)] (3-0-3)

# **MMAE 527**

### Heat Transfer: Convection & 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)]

(3-0-3)

### **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)]

(3-0-3)

### **MMAE 530**

### **Advanced Mechanics of Solids**

Mathematical foundations: tensor algebra, notation and properties, eigenvalues and eigenvectors. Kinematics: deformation gradient, finite and small strain tensors. Force and equilibrium: concepts of traction/stress, Cauchy relation, equilibrium equations, properties of stress tensor, principal stresses. Constitutive laws: generalized Hooke's law, anisotropy and thermoelasticity. Boundary value problems in linear elasticity: plane stress, plane strain, axisymmetric problems, Airy stress function. Energy methods for elastic solids. Torsion. Elastic and inelastic stability of columns.

Prerequisite(s): [(MMAE 501^{*})] An asterisk (^{*}) designates a course which may be taken concurrently. (3-0-3)

(0 0 0)

### 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)] (3-0-3)

### **MMAE 532**

### Advanced Finite Element Methods

Continuation of MMAE 451/CAE 442. Covers the theory and practice of advanced finite element procedures. Topics include implicit and explicit time integration, stability of integration algorithms, unsteady heat conduction, treatment of plates and shells, small-strain plasticity, and treatment of geometric nonlinearity. Practical engineering problems in solid mechanics and heat transfer are solved using MATLAB and commercial finite element software. Special emphasis is placed on proper time step and convergence tolerance selection, mesh design, and results interpretation. Prerequisite(s): [(CAE 442) OR (MMAE 451)] (3-0-3)

MMAE 533

# Fatigue & Fracture Mechanics

Analysis of the general state of stress and strain in solids; dynamic fracture tests (FAD, CAT). Linear elastic fracture mechanics (LEFM), Griffith-Irwin analysis, ASTM, KIC, KIPCI, KIA, KID. Plane stress, plane strain; yielding fracture mechanics (COD, JIC). Fatigue crack initiation. Goodman diagrams and fatigue crack propagation. Notch sensitivity and stress concentrations. Low-cycle fatigue, corrosion and thermal fatigue. Prerequisite: An undergraduate course in mechanics of solids. (3-0-3)

### **MMAE 536**

### **Experimental Solid Mechanics**

Review of applied elasticity. Stress, strain and stress-strain relations. Basic equations and boundary value problems in plane elasticity. Methods of strain measurement and related instrumentation. Electrical resistance strain gauges, strain gauge circuits and recording instruments. Analysis of strain gauge data. Brittle coatings. Photoelasticity; photoelastic coatings; moire methods; interferometric methods. Applications of these methods in the laboratory. Prerequisite: An undergraduate course in mechanics of solids. (3-2-4)

### **MMAE 540**

#### Robotics

Kinematics and inverse kinematics of manipulators. Newton-Euler dynamic formulation. Independent joint control. Trajectory and path planning using potential fields and probabilistic roadmaps. Adaptive control. Force control. Prerequisite(s): [(MMAE 443 and MMAE 501*)] An asterisk

(*) designates a course which may be taken concurrently. (3-0-3)

### MMAE 541

### **Advanced Dynamics**

Kinematics of rigid bodies. Rotating reference frames and coordinate transformations; Inertia dyadic. Newton-Euler equations of motion. Gyroscopic motion. Conservative forces and potential functions. Generalized coordinates and generalized forces. Lagrange's equations. Holonomic and nonholonomic constraints. Lagrange multipliers. Kane's equations. Elements of orbital and spacecraft dynamics. Additional Prerequisite: An undergraduate course in dynamics.

Prerequisite(s):  $[(MMAE 501^*)]$  An asterisk (*) designates a course which may be taken concurrently.

(3-0-3)

# 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.

 $\mbox{Prerequisite(s):} [(MMAE 501^*)]$  An asterisk (*) designates a course which may be taken concurrently.

(3-0-3)

# MMAE 544

## **Design Optimization**

Optimization theory and practice with examples. Finitedimensional 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.

(3-0-3)

# MMAE 545

## Advanced CAD/CAM

Interactive computer graphics in mechanical engineering design and manufacturing. Mathematics of three-dimensional object and curved surface representations. Surface versus solid modeling methods. Numerical control of machine tools and factory automation. Applications using commercial CAD/CAM in design projects.

Prerequisite(s): [(MMAE 445)] (3-0-3)

## **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. (3-0-3)

## **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. (3-0-3)

### **MMAE 551**

### **Experimental Mechatronics**

Team-based project. Microprocessor controlled electromechanical systems. Sensor and actuator integration. Basic analog and digital circuit design. Limited Enrollment. Prerequisite(s): [(MMAE 443)]

(2-3-3)

### **MMAE 554**

## Electrical, Magnetic & 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. (3-0-3)

### MMAE 555

### Introduction to Navigation Systems

Fundamental concepts of positioning and dead reckoning. Principles of modern satellite-based navigation systems, including GPS, GLONASS, and Galileo. Differential GPS (DGPS) and augmentation systems. Carrier phase positioning and cycle ambiguity resolution algorithms. Autonomous integrity monitoring. Introduction to optimal estimation, Kalman filters, and covariance analysis. Inertial sensors and integrated navigation systems.

Prerequisite(s): [(MMAE 443 and MMAE 501*)] An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

### **MMAE 556**

### Nanoscale Imaging & Manipulation

Includes an overview of scanning probe microscopy and of AFM imaging: mathematical morphology; imaging simulation and surface recognition; and high-speed AFM imaging. Also covers nanoscale physics, including probing nanoscale forces, van der Waals force, electrostatic force, and capillary force. Nanomanipulation topics such as mechanical scratching and pushing electrophoresis, and augmented reality. Manipulation automation and manipulation planning. Applications of selected topics covered. (3-0-3)

### **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. (3-0-3)

### **MMAE 560**

## Statistical Quality & 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. (3-0-3)

### MMAE 561

### Solidification & Crystal Growth

Properties of melts and solids. Thermodynamic and heat transfer concepts. Single and poly-phase alloys. Macro and micro segregation. Plane-front solidification. Solute boundary layers. Constitutional supercooling. Convection in freezing melts. Effective segregation coefficients. Zone freezing and purification. Single crystal growth technology. Czochralski, Kyropulous, Bridgman, and Floating Zone methods. Control of melt convection and crystal composition. Equipment. Process control and modeling. Laboratory demonstration. Prerequisite: A background in crystal structure and thermodynamics. (3-0-3)

### · /

### 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. (2-0-2)

### **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.

(3-0-3)

### **MMAE 564**

### **Dislocations & 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. (3-0-3)

### **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 processingmicrostructure-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. (1-6-3)

### **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)] (3-0-3)

# 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. (3-0-3)

# **MMAE 568**

### Diffusion

Theory, techniques and interpretation of diffusion studies in metals. Prerequisite: Background in crystal structures, defects, and thermodynamics. (2-0-2)

### 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. (3-0-3)

# MMAE 570

### **Computational Methods in Materials Processing**

Advanced theories and computational methods used in understanding and modeling of various materials processing that involve deformation, solidification, microstructural changes etc. This course will discuss the fundamental theories and mathematical models that describe the relevant physical phenomena in the computational framework of finite element method. If will consist of three parts: (1) Lectures on fundamental theories and models; (2) computational and numerical methods; (3) computer laboratories.Prerequisite: Background in finite element methods and materials processing. (3-0-3)

# MMAE 571

### Miscrostructural Characterization of Materials

Advanced optical microscopy. Scanning and transmission electron microscopes. X-ray microanalysis. Surface characterization. Quantitative microscopy. Elements of applied statistics. (2-3-3)

### **MMAE 573**

### Transmission Electron Microscopy

Design, construction and operation of transmission electron microscope, including image formation and principles of defect analysis in materials science applications. Theory and use of state-of-the-art micro characterization techniques for morphological, crystallographic, and elemental analysis at high spatial resolutions at 10 nanometers in metallurgical and ceramic studies will also be covered.

# (2-3-3)

# MMAE 574

## Ferrous Transformations

Allotropic modifications in iron and solid solution effects of the important alloying elements on iron. Physical metallurgy of pearlite, bainite and martensite reactions. Physical and mechanical property changes during eutectoid decomposition and tempering.Prerequisite: Background in phase diagrams and thermodynamics. (3-0-3)

### MMAE 576

### Materials & Process Selection

Context of selection; decision analysis; demand, materials and processing profiles; design criteria; selection schemes; value and performance oriented selection; case studies. (3-0-3)
#### 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.

#### (3-0-3)

#### **MMAE 585**

#### Engineering Optics & 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. (3-0-3)

#### **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. (3-0-3)

#### **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(s): [(MMAE 589)] (3-0-3)

#### MMAE 591

Research & Thesis M.S. Research and thesis writing. (Credit: Variable)

#### MMAE 593

#### MMAE Seminar

Reports on current research. Full-time graduate students in the department are expected to register and attend. (1-0-0)

#### **MMAE 594**

#### **Project for Master of Engineering Students**

Design projects for the master of mechanical and aerospace engineering, master of materials engineering, and master of manufacturing engineering degrees. (Credit: Variable)

#### **MMAE 597**

#### Special Topics

Advanced topic in the fields of mechanics, mechanical and aerospace, metallurgical and materials, and manufacturing engineering in which there is special student and staff interest. (Variable credit)

(Credit: Variable)

### **MMAE 600**

**Continuance of Residence** Continuance of residence. (0-0-1)

### MMAE 691

Research & Thesis Ph.D. Research and thesis writing. (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.

(2-0-2)

#### **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. (2-0-2)

### 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. (2-0-2)

#### (2-0-2)

#### 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.

(2-0-2)

#### **MMAE 710**

#### Dynamic & 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)]

(2-0-2)

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#### 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.

(2-0-2)

### 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. (2-0-2)

#### **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. (2-0-2)

# **Department of Physics**

Life Sciences Building 3101 S. Dearborn St. Chicago, IL 60616 312.567.3480 www.iit.edu/csl/physics

Chair: Christopher White

### **Degrees Offered**

Master of Health Physics Master of Science in Physics The Department of Physics offers B.S., M.S., and Ph.D. degrees in physics. Within the department, there are many opportunities for interdisciplinary education and research experiences; students in any of the disciplines have easy access to the expertise that the full faculty brings. In addition, the department offers a professional master's degree and related certificate program for part-time students, both on campus and through distance learning.

Master of Science in Applied Physics Doctor of Philosophy in Physics

# **Certificate Program**

Radiological Physics

# **Research Centers**

Center for Accelerator and Particle Physics Center for the Molecular Study of Soft and Condensed Matter Center for Synchrotron Radiation Research and Instrumentation

# **Research Facilities**

The department has state-of-the-art computer and laboratory equipment and conducts research in the areas of elementary particle physics, accelerator and plasma physics, condensed-matter physics, biological physics, xray optics, x-ray imaging, and quantum theory. The department constructs and operates facilities for x-ray scattering, spectroscopy, and imaging at the Advanced Photon Source at Argonne National Laboratory. Additional research facilities include on-campus x-ray diffraction facilities, thin-film growth facilities, a high-field nuclear magnetic resonance facility, Fourier transform infrared spectrometers, and atomic force microscopes. Laboratories for experimental research in biophysics, lowtemperature, solid-state physics, and particle physics are active. Collaborative programs are carried on with Fermi National Accelerator Laboratory, Argonne National Laboratory, and the Advanced Photon Source. The department hosts the Center for Accelerator and Particle Physics (CAPP), the Center for the Molecular Study of Soft and Condensed Matter, and the Center for Synchrotron Radiation Research and Instrumentation (CSRRI).

# Faculty

Betts, R. Russell, Professor and Dean of the College of Science and Letters. B.A., M.A., Oxford University; M.S., Ph.D., University of Pennsylvania. Nuclear Physics.

Bunker, Grant, Professor, Acting Chair for Biological and Chemical Sciences, and Associate Dean for Research, College of Science and Letters. B.A., Evergreen State College; Ph.D., University of Washington. X-ray absorption spectroscopy, biophysics, synchrotron radiation research, computational physics/chemistry.

Burnstein, Ray A., Emeritus and Research Professor. B.S., University of Chicago; M.S., University of Washington; Ph.D., University of Michigan. Experimental elementary particle physics, interactive teaching and technology.

Chattopadhyay, Soma, Research Assistant Professor. B.S., M.S., University of Calcutta (India); Ph.D., Tata Institute of Fundamental Research (India).

Coffey, Liam, Associate Professor. B.A., Trinity College (Ireland); Ph.D., University of Chicago. Condensed matter theory.

Erber, Thomas, Distinguished Emeritus Professor. B.S., Massachusetts Institute of Technology; M.S., Ph.D., University of Chicago. Electrodynamics, magnetism, fatigue, complex systems.

Gidalevitz, David, Associate Professor. B.S., M.S., Urals Technical University (Russia); Ph.D., Weizmann Institute of Technology (Israel). Membrane biophysics, biomaterials, drug delivery, biosensors and biomimetic thin films, and polymer films.

Glodowski, Alan, Senior Lecturer and Associate Chair. B.S., University of Wisconsin; M.S., Creighton University.

Hanlet, Pierrick, Research Assistant Professor. B.S., State University of New York-Stony Brook; Ph.D., University of Virginia.

Howard, Andrew J., Associate Professor of Biology and Physics. B.A., Pomona College; Ph.D., University of California-San Diego. Methods Development and Macromolecular crystallography. Biochemistry, Molecular Biochemistry and Biophysics.

Irving, Thomas C., Professor of Biology, Physics, and Biomedical Engineering and Executive Associate Chair -Biology, Biological and Chemical Sciences. B.Sc., M.Sc., Ph.D., University of Guelph (Canada). Structure and biophysics of macromolecular systems, muscle structure and physiology, synchrotron radiation instrumentation. Biochemistry, Molecular Biochemistry and Biophysics.

Johnson, Porter W., Emeritus Professor. B.S., Case Institute of Technology; M.A., Ph.D., Princeton University. Elementary particle theory, science education. Kallend, John, Professor of Materials Engineering and Physics. B.A., M.A., Ph.D., Cambridge University (England). Computational methods of crystallographic texture analysis and properties of polycrystalline aggregates.

Kaplan, Daniel, Professor. B.A., Haverford College; Ph.D., State University of New York-Stony Brook. Experimental high-energy physics, especially symmetry violation and rare decays of hyperons and charm and beauty hadrons, electronics for high-speed triggering and data acquisition.

Mishra, Bhoopesh, Research Assistant Professor. B.Sc., Science College, Patna University (India); M.Sc., Indian Institute of Technology (India); Ph.D., University of Notre Dame.

Morrison, Timothy, Professor and Faculty Laboratory Safety Coordinator. B.A., Western Michigan University; Ph.D., University of Illinois, Urbana-Champaign. Solidstate physics, catalysts, x-ray absorption, x-ray optics.

Rubin, Howard A., Professor Emeritus. B.S., Massachusetts Institute of Technology; Ph.D., University of Maryland. Experimental elementary particle physics.

Schieber, Jay, Professor of Chemical Engineering and Physics and Director of the Center for the Molecular Study of Condensed Soft Matter. Ph.D., University of Wisconsin-Madison. Experiment, theory, and computation in the multiscale study of soft matter, including both biological and synthetic materials.

Scott, H. Larry, Professor. B.S., Ph.D., Purdue University. Theoretical modeling and computer simulation of lipid bilayers and model biological membranes.

Segre, Carlo U., Duchossois Leadership Professor of Physics and Director of the Center for Synchrotron Radiation Research and Instrumentation (CSRRI). B.S. (Physics), B.S. (Chemistry), University of Illinois, Urbana-Champaign; M.S., Ph.D., University of California-San Diego. Experimental condensed-matter physics, superconductivity, x-ray structural studies of complex materials.

Shibata, Tomohiro, Research Assistant Professor. B.Sc., M.Sc., Doctor of Science, University of Tokyo (Japan).

Snopok, Pavel, Assistant Professor and Scientist at Fermi National Accelerator Laboratory. M.S., Ph.D., Saint-Petersburg State University (Russia); M.S., Ph.D., Michigan State University. Accelerator physics.

Spector, Harold N., Emeritus Professor. B.A., M.S., Ph.D., University of Chicago. Solid-state theory, electronic and optical processes and semi-conducting nanostructures.

Spentzouris, Linda Klamp, Associate Professor. B.A., Colorado College; Ph.D., Northwestern University. Accelerator physics.

# Faculty continued

Sullivan, Zack, Assistant Professor. B.A., Johns Hopkins University; M.S., Ph.D., University of Illinois, Urbana-Champaign. Theoretical Particle Physics beyond the Standard Model.

Terry, Jeffrey, Associate Professor. B.S., University of Chicago; Ph.D., Stanford University. Synchroton radiation techniques.

Torun, Yagmur, Associate Professor and Guest Scientist at Fermi National Accelerator Laboratory. B.S., Middle East Technical University; Ph.D., Stony Brook University. Accelerator and High Energy Physics. White, Christopher G., Professor and Chair. B.S., University of Illinois, Urbana-Champaign; Ph.D., University of Minnesota. Experimental elementary particle physics.

Zasadzinski, John, Paul and Suzie Schutt Professor of Science. B.S., Illinois Benedictine College; Ph.D., Iowa State University. Solid state physics.

Zwicker, Earl, Emeritus Professor of Physics. B.S., University of Wisconsin; Ph.D., Illinois Institute of Technology. Physics education.

### **Admission Requirements**

Cumulative undergraduate GPA minimum: 3.0/4.0 TOEFL minimum:  $550/213/80^*$ 

The Graduate Record Examination (GRE) is required for all applicants. The GRE minimum scores are:

Ph.D.: 310 (quantitative + verbal),

3.0 (analytical writing)

M.S.: 295 (quantitative + verbal),

2.5 (analytical writing) MAS: 295 (quantitative + verbal),

2.5 (analytical writing)

Applicants to the doctoral program in physics are strongly encouraged, but not required, to take the subject-area GRE exam in physics. Meeting the minimum GPA and test score requirements does not guarantee admission. Test scores and GPA are just two of several important factors considered.

Applicants to the department's program are expected to have a bachelor's degree from an accredited institution with a major in that same discipline, or a closely allied major with additional coursework that prepares the student for graduate study in the chosen program. Students who have not completed all required courses may be accepted for general admission and can begin coursework, but must remove any deficiencies before the MAS or M.S. comprehensive/Ph.D. qualifying examination.

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

### **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.

All students in the professional master's degree program are required to take and pass a comprehensive exam. Students may sit for the exam a limited number of times.

# Degrees

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 the part-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 advisor.

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 advisor and must obtain the approval of the advisor each semester before registering for any graduate classes.

# Bachelor of Science/Master of Health Physics - Co-Terminal Degree

Undergraduate students may register for the co-terminal Bachelor of Science/Master of Health Physics after the fourth semester of study. Students must fulfill the requirements of both the Bachelor of Science and the Master of Health Physics. A full course of study is approximately 10 semesters of study, and graduate coursework

# Master of Health Physics

30 credit hours minimum Comprehensive examination

Designed primarily for working professional health physicists in government, medicine, research, and industry, this program combines technical depth with the interdisciplinary viewpoints of leadership, management, and communications. The degree can be completed in four semesters and two summer sessions of part-time study. Applicants must have completed coursework in calculus through differential equations and a calculus-based general physics sequence. A course in modern physics, including some basic quantum mechanics, is strongly recommended.

This program is also available on the Web, and at televised viewing sites throughout the Chicago area. Students should consult http://iit.edu/iit_online/ for more information.

typically begins in the fourth year. For further details, refer to "Co-Terminal Degrees" in Campus Resources, and a full description of the program can be found in the Undergraduate Bulletin.

### **Required Courses**

PHYS $561$	Radiation Biophysics
PHYS $566$	Environmental Health Physics
OR	
PHYS $579$	Therapeutic Medical Physics II
PHYS $571$	Radiation Physics I
PHYS $572$	Radiation Physics II
PHYS $573$	Standards, Statutes, and Regulations
PHYS $575$	Case Studies in Health Physics
PHYS $576$	External Dosimetry
PHYS $577$	Internal Dosimetry
PHYS $578$	Therapeutic Medical Physics I
PHYS $770$	Instrumentation for Radiation Health
	Physics
COM 523	Communicating Science
CHEM 513	Statistics for Analytical Chemists
INTM $511$	Industrial Leadership
OR	
PHYS $563$	Business Principles/Project Management

# Master of Science in Physics

32 credit hours Comprehensive examination Thesis and oral defense (optional)

For those interested in research, seven to nine credit hours of PHYS 591 (Thesis Research) may be applied to the 32-credit-hour requirement. The basic program of coursework must include two semesters of PHYS 585 or PHYS 685 (Colloquium) and the M.S. core:

### Master of Science in Applied Physics

32 credit hours Comprehensive examination

The Master of Science in Applied Physics is a rigorous graduate degree program designed specifically for the undergraduate engineering major. The traditional Bachelor of Science degree in engineering only requires about one year of university physics. This is not enough time to be exposed to the physics of the 20th century. This becomes a serious deficiency for those engineering students seeking careers in the nanotechnology industry or those pursuing advanced degrees in fields where a solid knowledge of physics is required. The fields of laser technology, optics, semi-conductors, nuclear energy, nanofabrication, and biotechnology all demand applied physics. IIT's Master of Science in Applied Physics is designed to provide the undergraduate engineering major with this fundamental knowledge of physics that they need for a successful career.

For students in the IIT-Paris double degree program, the program can be completed in one calendar year by taking classes in the fall, spring, and summer semesters. For students enrolled in undergraduate engineering on IIT's **Required Courses** 

PHYS $501$	Methods of Theoretical Physics I
PHYS $505$	Electromagnetic Theory
PHYS $508$	Analytical Dynamics
PHYS $509$	Quantum Theory I
PHYS $510$	Quantum Theory II
PHYS $515$	Statistical Mechanics

The remaining course requirements may be satisfied by additional graduate or advanced undergraduate electives.

main campus, there is the option of earning a Bachelor of Engineering and Master of Science in Applied Physics in just five years through a co-terminal degree program.

#### **Required Courses**

PHYS $405$	Fundamentals of Quantum Theory I	
PHYS 406	Fundamentals of Quantum Theory II	
PHYS $501$	Methods of Theoretical Physics I	
PHYS $505$	Electromagnetic Theory	
PHYS $508$	Analytical Dynamics	
PHYS $515$	Statistical Mechanics	
AND		
PHYS $585$	Physics Colloquium (taken twice)	
OR		
PHYS $685$	Physics Colloquium (taken twice)	
AND		
DITIO NO.		

PHYS 597 Reading and Special Problems

#### Engineering or Physics Electives (12 credit hours)

Four courses selected in consultation with the academic advisor may be used for elective credits. At least two of these courses must be from an engineering discipline.

# **Doctor of Philosophy in Physics**

84 credit hours Written qualifying examination Comprehensive examination Dissertation and oral defense

The requirements for the degree consist of a program of 84 credit hours approved by the faculty advisor; 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 section "Transfer Credits" in this bulletin for rules on how many credit hours may be transferred from another institution. The required coursework includes 4 semesters of PHYS 585 or PHYS 685 (Colloquium) and the graduate core:

### **Required Courses**

- PHYS 501 Methods of Theoretical Physics I
- PHYS 505 Electromagnetic Theory
- PHYS 508 Analytical Dynamics
- PHYS 509 Quantum Theory I
- PHYS 515 Statistical Mechanics

#### AND at least three from the following:

PHYS 502 Methods of Theoretical Physics II PHYS 507 Electrodynamics PHYS 510Quantum Theory II Group Theory in Physics PHYS 533PHYS 537 Solid State Physics I PHYS 538Solid State Physics II PHYS 539 Physical Methods of Characterization Particle Physics I PHYS 545PHYS 546 Particle Physics II PHYS 553 Quantum Field Theory PHYS 561 **Radiation Biophysics** PHYS 570Introduction to Synchrotron Radiation

The remaining course requirements may be satisfied by additional graduate or advanced undergraduate electives and research. 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 advisor. Students must have passed the written qualifying examination before registering for PHYS 691 (Ph.D. Thesis Research).

### **Certificate in Radiological Physics**

### 12 total credits selected from:

- PHYS 561 Radiation Biophysics
- PHYS 566 Environmental Health Physics
- PHYS 571 Radiation Physics I
- PHYS 572 Radiation Physics II
- PHYS 573 Standards, Statutes and Regulations
- PHYS 575 Case Studies in Health Physics
- PHYS 576 Internal Dosimetry
- PHYS 578 Therapeutic Medical Physics I
- PHYS 579 Therapeutic Medical Physics II
- PHYS 770 Instrumentation for Radiation Health Physics

# **Course Descriptions**

Numbers in parentheses indicate class, lab, and credit hours, respectively.

An asterisk (*) designates a course which may be taken concurrently.

#### PHYS 501

#### Methods of Theoretical Physics I

Vector analysis including curvilinear coordinates. Tensor algebra. Ordinary differential equations and special functions. Complex variables algebra, Cauchy-Riemann conditions, harmonic functions. Cauchy theorem, Cauchy formula. Laurent series. Residues calculus, calculation of integrals using residues. Partial differential equations: separation of variables, Fourier series methods. Laplace, wave, diffusion equations in Cartesian, cylindrical and spherical systems of coordinates. Special functions and orthogonal polynomials: Bessel functions, Legendre polynomials, associated Legendre polynomials, Hermite, Laguerre, etc. polynomials. (3-0-3)

#### PHYS 502

#### Methods of Theoretical Physics II

Green functions. Their connection with a complex variables calculus. Advanced, retarded, causal GF. Group theory. Discrete groups, elementary examples and properties. Lie groups, their fundamental properties, applications in quantum mechanics. O(3), SU(2), SU(3), Lorentz groups and their applications in quantum theory. Basic ideas of differential geometry and topology. Path integrals. Special topics specified on the year-by-year basis. (3-0-3)

(3-0-3)

### PHYS 505

#### **Electromagnetic Theory**

Maxwell equations including a derivation of their macroscopic version. Electrostatics, magnetostatics. Electromagnetic waves, dipole radiation, beyond the dipole radiation (quadruple and magneto-dipole radiation); scattering of electromagnetic waves. Gradient (gauge) invariance, special relativity, Lorentz invariant formulation of electrodynamics, Maxwell equations in relativistic invariant form; Lienard-Wiechert fields, relativistic charge electromagnetic field, basic ideas of synchrotron radiation.

(3-0-3)

# PHYS 507

#### Electrodynamics

Covariant formulation of Maxwell's equations. Variational principles of classical field theory. Theory of radiation reactions. Topics in contemporary electrodynamics. Prerequisite(s): [(PHYS 505) (3-0-3)

### PHYS 508

#### Analytical Dynamics

Newton's laws. Lagrange's equations. Central forces. Invariance properties and conservation laws. Collections of particles. Rigid body motions. Small vibrations. Hamilton's equations. Canonical transformations. Hamilton-Jacobi theory. Approximation methods. Special theory of relativity. Classical theory of fields. Undergraduates may take the course with permission of their advisor and their instructor. (3-0-3)

# 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. (3-0-3)

### PHYS 510

#### Quantum Theory II

Algebra of angular momenta. Rotation Group. Abstract group theory, Lie algebra, generators, structure constants. O(3), SU(2), SU(3), Lorentz group examples. Scattering theory. S-matrix. Lippmann-Schwinger Equation. Partial wave analysis. Second quantization. Its applications. Bogolyubov transformations. Relativistic Quantum Mechanics. Klein-Gordon Equation. Dirac Equation. Prerequisite(s): [(PHYS 509)]

(3-0-3)

### **PHYS** 511

#### Advanced Quantum Mechanics I

Applications and extensions of basic principles introduced in PHYS 509 and 510. Typical subject areas include atomic and molecular structure, group-theoretical analysis of spectra, many-body problems, including second quantization, density matrix. Hartree-Fock method. BCS theory. Introduction to quantum fields. Feynman diagrams. Green's functions, quantum electrodynamics.

Prerequisite(s): [(PHYS 509 and PHYS 510)]

#### (3-0-3) PHYS 512

### Advanced Quantum Mechanics II

Applications and extensions of basic principles introduced in PHYS 509 and 510. Typical subject areas include atomic and molecular structure, group-theoretical analysis spectra, many-body problems, including second quantization, density matrix. Hartree-Fock method. BCS theory. Introduction to quantum fields. Feynman diagrams. Green's functions, quantum electrodynamics.

Prerequisite(s): [(PHYS 509 and PHYS 510)] (3-0-3)

#### 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. (3-0-3)

#### _....

#### 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. (3-0-3)

#### 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 406)]

(3-0-3)

#### **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 406)] (3-0-3)

#### 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. (3-0-3)

### **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.

 $\operatorname{Prerequisite}(s) : \ [(PHYS \ 509 \ and \ PHYS \ 510)]$ 

(3-0-3)

### PHYS 546

#### Particle Physics II

The course is a continuation of PHYS 545 but is selfcontained. The goal is to provide a functional understanding of particle physics phenomenology of QED, QCD, and electroweak physics. Topics include QED: Spin-dependent cross sections, crossing symmetries, C/P/CP QCD: Gluons, parton model, jets Electroweak interactions: W, Z, and Higgs. Weak decays and production of weak bosons Loop calculations: Running couplings, renormalization. Prerequisite(s): [(PHYS 509 and PHYS 510)]

(3-0-3)

#### PHYS 553

#### **Quantum Field Theory**

Relativistic wave equations. Semiclassical and quantum theories of radiation. Photoelectric effect. Pair production. Bremsstrahlung. Compton scattering. Second quantization of the electron field. Renormalization. Lamb shift. Vacuum polarization. Exact methods for external field problems. (3-0-3)

#### **PHYS 561**

#### **Radiation Biophysics**

Energy loss by ionizing radiation. Target theory. Direct and indirect action. Radiation effects in biomolecules. Radiation inactivation of enzymes, nucleic acids, and viruses. Biological effects of ultraviolet radiation. Photosensitization. Radiation protection and sensitization. Radiation effects in vivo, radiation therapy, and phototherapy.

Prerequisite(s): [(PHYS 410)]

#### (3-0-3)

#### 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. (2-0-2)

#### **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 decommunation.

Prerequisite(s): [(PHYS 572)] (2-0-2)

#### **PHYS 570**

#### Introduction to Synchrotron Radiation

Production and characterization of synchrotron radiation, dynamical and kinematical diffraction, absorption and scattering processes, x-ray optics for synchrotron radiation and x-ray detectors. Overview of experimental techniques including XAFS, XPS, SAXS, WAXS, diffraction, inelastic x-ray scattering, fluorescence spectroscopy, microprobe, tomography and optical spectroscopy. (3-0-3)

#### PHYS 571

#### Radiation Physics I

Fundamentals of health physics will be presented with an emphasis on problem-solving. Topics covered begin with the physics of radiation production: review of atomic and nuclear structure and quantum mechanics; radioactivity; and production of x-rays. The second part of the course focuses on the interaction of radiation with matter including energy-loss mechanisms, secondary processes, stopping power, and range. (3-0-3)

#### **PHYS 572**

#### **Radiation Physics II**

Continuation of the basic health physics sequence including neutron production and interaction with matter, nuclear energy and nuclear fuel cycle, nuclear reactors, methods of radiation detection including gas-based detectors and semiconductor detectors, statistics in health and medical physics, radiation dosimetry including Bragg-Gray and Spencer-Attix cavity theories, radiation protection standards, shielding, dosimetric models, accelerator, and reactor health physics.

Prerequisite(s): [(PHYS 571)] (3-0-3)

#### PHYS 573

#### Standards, Statutes & 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. (3-0-3)

#### PHYS 575

#### **Case Studies in Health Physics**

Issues in operational health physics and regulatory affairs. Students will present problems and solutions drawn from their experience and the literature. Operational problems may include organizational issues, computer applications, measurements and dosimetry. Methods for compliance with EPA, NRC, and OSHA and enforcement actions will emphasize technical and management techniques. Prerequisite(s): [(PHYS 572)]

(3-0-3)

### PHYS 576

#### Internal Dosimetry

Calculation of internal dose from radiation sources. Internal dose is a function of the form of radioactive material, route of intake, biochemistry, metabolic activity, and gross cellular physiology.

Prerequisite(s): [(PHYS 571* and PHYS 572)] (2-0-2)

### PHYS 577

#### External Dosimetry

Calculation of external dose from radiation sources. external dose is determined for uniform fields, non-uniform, and local deposition. external sources include immersion in a cloud of radioactive gas and skin contamination. (2-0-2)

## PHYS 578

#### Therapeutic Medical Phyics I

Fundamentals of therapeutic medical physics are presented with emphasis on clinical applications and problem solving. Topics covered include the following: review of basic radiation interactions with matter relevant in medical physics; description of radiation producing devices in the hospital environment including x-ray tubes for diagnostic imaging and high-energy treatment machines for external beam radiotherapy including radioisotope-based machines (Co-60) and clinical x-ray, electron and proton radiotherapy accelerators; properties of clinical x-ray and electron beams; radiation detectors in medical physics; and calibration of external x-ray and electron beams.

Prerequisite(s): [(PHYS 572)] (2-0-2)

#### **PHYS 579**

#### Therapeutic Medical Physics II

Advanced topics in radiation therapy physics will be covered. Topics begin with three-dimensional conformal radiation therapy followed by clinical dose computation algorithms: convolution-superposition methods and direct Monte Carlo methods. Following topic is Intensity Modulated Radiation Therapy (IMRT), which will cover mathematical, physical, and biological optimizations of beam intensity, IMRT dose delivery methods, and quality assurance aspects. Brachytherapy: Low Dose Rate (LDR) and High Dose Rate (HDR); Stereotactic Radiosurgery (SRS) and Stereotactic Body Radiation Therapy (SBRT); and Proton Radiotherapy. Prerequisite(s): [(PHYS 578)] (2-0-2)

# 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. (1-0-1)

#### (101)

### PHYS 591

**Research & Thesis M.S.** Prerequisite: Instructor permission required. (Credit: Variable)

### PHYS 597

#### Reading & 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. Prerequisite: Instructor permission required.

(Credit: Variable)

# PHYS 600

Continuation of Residence

Continuation of residence. (0-0-1)

#### **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. or Ph.D. students. (1-0-0)

#### **PHYS 691**

**Research & Thesis Ph.D.** Research and thesis writing. (Credit: Variable)

#### PHYS 770

#### Instrumentation for Radiation Health Physics

Detecting and measuring radioactive material and radiation levels depends upon many types of detectors and instrumentation. Theory of detectors ranging from chambers operating in pulse and current producing modes to solid state detectors is applied to measuring and monitoring systems. Electronics ranging from simple rate meters and scalers to high speed multi-channel analyzers is used. Computer linked instrumentation and computer based applications are applied to practical problems.

(3-4-3)

# **College of Psychology**

Life Sciences Building 3105 S. Dearborn St. Chicago, IL 60616	Division Head, Industrial, Organizational and Business Psychology: Roya Ayman
312.567.3500 psychology@iit.edu www.iit.edu/colleges/psych	Division Head, Counseling and Rehabilitation Science: Frank Lane
Dean:	
M. Ellen Mitchell	The College of Psychology offers graduate programs
Associate Dean: Scott B. Morris	in Clinical Psychology, Industrial/Organizational (I/O) Psychology/Psychology Counseling, and Rehabilitation. The college'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.
<b>Division Head, Clinical Psychology:</b> Michael Young	

# **Degrees Offered**

Master of Science in Personnel and Human Resource	Doctor of Philosophy in Psychology
Master of Science in Psychology	Industrial/Organizational, Rehabilitation
Master of Science in Rehabilitation Counseling	Postdoctoral Retraining in Clinical Psychology

University.

# **Combined Degree Programs**

Bachelor of Science in Psychology/Master of Science in Personnel and Human Resources Development

Bachelor of Science in Psychology/Master of Science in Rehabilitation Counseling

powerment. The consortium, largely funded by NIMH,

is located at Illinois Institute of Technology, directed by

Patrick Corrigan, and includes a collection of researches at Yale University, the University of Pennsylvania, Rut-

gers University, Temple University, Dartmouth Univer-

sity, the University of Illinois-Chicago, and New York

# **Research Centers**

Psychology faculty and students collaborate on applied research projects through the Center for Research and Service.

The National Consortium on Stigma and Empowerment (NCSE) is a reasearch group meant to promote recovery from mental illness by understanding the stigma associated with mental illness and promoting personal em-

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 is part of the research

**Research Areas** 

Clinical psychology faculty interests include: health psychology, attachment, child social and emotional development, educational assessment, eating disorders, and mood disorders. Some clinical students work with Rehabilitation faculty in areas such as: adjustment to disability, stages of change, stigma and prevention, psychiatric rehabilitation, and cross-cultural issues. facilities. There are graduate student offices, a testing library, and a student lounge. The University Center for Disability Resources is housed within the College of Psychology. Many journals and databases are available through IIT's libraries.

Industrial/Organizational faculty interests include: leadership, diversity, organizational climate, work-family interface, training design and evaluation, performance appraisal, test development, selection bias, and item response theory. Rehabilitation faculty pursue research in the areas of: adjustment to disability, vocational rehabilitation, factors affecting job placement, rehabilitation engineering technology, and psychiatric rehabilitation.

# Faculty

Ayman, Roya, Professor and Division Head of Industrial, Organizational, and Business Psychology. B.A., M.A., Ph.D., University of Utah. Leadership, diversity, organizational climate, and work-family interface.

Corrigan, Patrick, Distinguished Professor and Associate Dean for Research, College of Psychology. B.S., Creighton University; M. A., Roosevelt University; Psy.D., Illinois School of Professional Psychology. The stigma of disabilities, the disabilities and rehabilitation of people with serious mental illness.

Ditchman, Nicole, Assistant Professor. B.S., M.S. University of Illinois, Urbana-Champaign; Ph.D., University of Wisconsin-Madison. School-to-work transition, social relationships, and community engagement of individuals with disabilities.

Ellington, J. Kemp, Assistant Professor. B.S., Appalachian State University; M.S., Ph.D., North Carolina State University. Training evaluation and effectiveness, performance appraisal issues such as rater effects, contextual influences, and developmental feedback.

Geist, Glen, Professor Emeritus. B.A., Allegheny College; M.S., Ph.D., State University of New York-Buffalo. Private rehabilitation, job placement.

Haedt-Matt, Alissa, Assistant Professor. B.S., M.A., Ph.D., University of Iowa. Eating and weight disorders and associated psychopathology.

Hopkins, Joyce, Associate Professor. B.A., McGill University; M.A., Tufts University; Ph.D., University of Pittsburgh. Infant/maternal attachment, high-risk infants and toddlers, maternal psychopathology, and infant development.

Houston, Eric, Assistant Professor. B.A., Carlton College; M.A., Ph.D., University of Illinois-Chicago. Relationship between health outcomes and psychological factors and treatment motivation.

Huyck, Margaret, Professor Emerita. A.B., Vassar College; M.A., Ph.D., University of Chicago. Gerontology, adult development.

Kazukauskas, Kelly A., Clinical Assistant Professor. B.S., Texas A&M University; M.S., Ph.D., Illinois Instutute of Technology. Rehabilitation counselor competency and training/ethics, sexuality and disability, development disabilities, traumatic brain injury.

Lam, Chow, Professor Emeritus. B.S., M.S.ed., University of Wisconsin-Whitewater; Ph.D, University of Wisconsin-Madison. Stages of change, cross-cultural issues in rehabilitation.

Landis, Ronald S., Nambury S. Raju Professor. B.A., Pennsylvania State University; M.A., Ph.D., Michigan State University. Quantitative research methods, measurement, philosophy of science, personnel selection, individual and team performance, and recruitment. Lane, Frank J., Associate Professor and Head of Rehabilitation Psychology Division. B.A., St. Leo College; M.H.S., Ph.D. University of Florida. Rehabilitation technology, applied ethics, attitudes, crime, and disability.

Larson, Jonathan, Assistant Professor. B.A., Western Illinois University; M.S., Southern Illinois University; Ed.D., Roosevelt University. Staff burnout, psychiatric rehabilitation, supported employment, stigma, mental health leadership.

Lee, Eun-Jeong, Assistant Professor. B.A., M.A., The Catholic University of Korea; Ph.D., University of WisconsinMadison. Cognitive Vulnerability Model of Depression for people with disabilities, psychosocial aspects to people with disabilities, positive psychology and disability, research methodologies, and epilepsy rehabilitation.

Mead, Alan, Assistant Professor and Scientific Advisor to the Center for Research and Service. B.A., M.A., Ph.D., University of Illinois, Urbana-Champaign. Technological and methodological research areas, including applications of psychometric theory, data mining, computerized testing, analysis software; also individual differences theories of personality and culture.

Miller, Jennifer L., Assistant Professor. B.A., University of Tennessee; M.S., Ph.D., Indiana University. Development of communication in complex social networks.

Mitchell, M. Ellen, Professor, Dean of the College, and Deputy Director of the Institute of Science, Law, and Technology. B.A., Hamilton/Kirkland College; Ph.D., University of Tennessee. Social support, family and marital therapy.

Moller, Arlen, Associate Professor. B.A., Cornell University; M.A., Ph.D., University of Rochester. Wellness, motivation, use of technology to promote healthy lifestyle.

Morris, Scott, Professor and Associate Dean. B.A., University of Northern Iowa; M.A., Ph.D., University of Akron. Personnel selection, employment discrimination, statistics.

Saxena, Mahima, Visiting Assistant Professor. B.A., University of Delhi (India); M.Sc., Goldsmiths, University of London (United Kingdom).

Schleser, Robert, Professor. B.A., Rutgers University; M.S., Ph.D., Memphis State University. Developmental issues, educational evaluation.

Stanard, Steven, Visiting Associate Professor. B.A., Illinois State University; M.A., Xavier University; Ph.D., Illinois Instutute of Technology. Executive coaching, managerial assessment, police selection and promotion.

Wolach, Allen, Professor Emeritus. B.A., University of Illinois; M.A., Roosevelt University; Ph.D., University of New Mexico. Statistical packages, learning models. Young, Michael, Professor and Division Head of Clinical Programs. A.B., University of Chicago; M.A., Ph.D., Adelphi University. Seasonal affective disorder, cognitive models of depression, statistical modeling of psychopathology.

### Admission Requirements

Cumulative undergraduate GPA minimum: 3.0/4.0 GRE score minimum for M.S./Ph.D.:

1000 (quantitative + verbal) 3.0 (analytical writing)  $\,$  - before August 2011

GRE score minimum for M.S./Ph.D.:

298 (quantitative + verbal) 3.0 (analytical writing) - after August 2011

Minimum TOEFL score: 550/213/80*

The faculty of the College of Psychology place primary emphasis on the GRE scores in the verbal and quantitative sections. The master's program in Rehabilitation Counseling does not require the GRE. 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, with at least one course each in experimental psychology and statistics, 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 masters in Rehabilitation 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 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). Therefore, a prospective student must designate a specialty area on the appropriate form.

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

### **Program Descriptions**

The Clinical Psychology Division offers a Ph.D. degree in Clinical Psychology. The Clinical Psychology Ph.D. program has been fully accredited for over 25 years by the American Psychological Association, and offers training from the cognitive-behavioral framework. Based on the Boulder scientist-practitioner model, the program emphasizes an integration of clinical practice and applied clinical research. Working with a faculty mentor, students begin research work their first year. Students in the rehabilitation specialization track take rehabilitation courses as electives and do research with Rehabilitation faculty. Clinical practicum experiences take place at general and specialized clinical sites throughout the Chicago area. All students complete an APA-accredited internship. The program prepares students to be licenseeligible in the state of Illinois. Graduates typically function as practitioners and researchers in medical centers and multi-disciplinary clinical settings.

The Industrial, Organizational, and Business Psychology Division offers an M.S. degree in Pesonnel and Human Resource Development and a Ph.D. in Industrial/Organizational Psychology. The Division emphasizes students' exposure to the scientists' and practitioners' viewpoints of the field. Students undertake a balanced education in personnel and organizational topics, disciplines and research. The program strengthens students' quantitative skills for research and consulting. All students are expected to complete two internships. These positions are within various organizations where students are responsible for human resource management and development functions. Students in the Personnel and Human Resource Development master's degree program receive the knowledge and skills necessary for professions in human resources, as well as management consulting positions. Ph.D. students will acquire a strong theoretical and methodological background in various areas of I/O psychology and are required to complete a minimum of two research projects. Many students in the past have presented and published their work. The Ph.D. curriculum prepares students to choose from several career paths in consulting, corporate human resources, or research and teaching.

The Counseling and Rehabilitation Science Division offers an M.S. degre in Rehabilitation Counseling, a Ph.D. in Rehabilitation Counselor Education, and a Ph.D. in combined Clinical/Rehabilitation Psychology. The mission of the Rehabilitation Counseling program is to prepare master's degree students to perform a vital role as counselors in the vocational, educational, and personal adjustment of persons with physical, mental, and emotional disabilities. The objectives of the program are to: (1) Train individuals in knowledge most relevant to the practice of rehabilitation counseling and (2) Develop mature, capable professionals who are able to relate constructively to clients, to understand normal and deviant behavior, demonstrate therapeutic interactive skills, and to facilitate the client's development of problem solving skills. The program also provides advanced training for persons presently employed in agencies and facilities offering services to persons with disabilities. It prepares counselors for employment in state, federal, and private rehabilitation agencies; hospitals; correctional institutions; public schools; rehabilitation centers; and other organizations serving persons with physical, psychiatric, mental, social or emotional disabilities. The Ph.D. program prepares individuals for careers in university teaching, research and clinical practice in Rehabilitation Psychology. A minor is required for the rehabilitation counseling education track.

# Master of Science in Personnel and Human Resources Development

43 credit hours

The M.S. in Personnel and Human Resources Development is designed for individuals who wish to work as applied professionals in areas such as management consulting, human resource management, industrial relations, and consumer behavior.

#### **Core Course Requirements**

PSYC 511 Psychometric Theory
PSYC 529 Personnel Selection and Evaluation
PSYC 545 Graduate Statistics I
PSYC 556 Graduate Statistics II
PSYC 556 Organizational Psychology
PSYC 558 Internship
PSYC 559 Internship

# Master of Science in Psychology

32 credit hours Thesis and oral defense

The M.S. in Psychology is almost exclusively a preliminary degree for students working toward a Ph.D. The aim is to evaluate and prepare students for work beyond the M.S.

### **Required Courses**

PSYC 545 Graduate Statistics I PSYC 546 Graduate Statistics II PSYC 591 Research and Thesis for the M.S. Degree

# Required Courses (must be completed within two years after the sequence is started)

PSYC 501 Physiological Foundations of Behavior PSYC 502 Social Bases of Behavior PSYC 503 Learning, Cognition, and Motivation

PSYC 504 Individual and Cultural Differences

This sequence constitutes the comprehensive requirement for the degree. Students must complete it with a These core courses provide a broad understanding of human relations in the workplace through theory and practice. Electives in industrial/organizational psychology, vocational rehabilitation, public administration, law and business allow for specialization. Designed as a two year full-time program with a minimum of 43 credit hours required, it also can be undertaken on a part-time basis. A research thesis or project is not required. Completing each I/O and statistics course with a minimum of a "B" (or appropriate remedial work determined by the college) constitutes the comprehensive requirement. There is no foreign language requirement.

Minimum requirements for admission include a bachelor's degree from an accredited institution, a minimum undergraduate GPA of 3.1/4.0, GRE results, and favorable recommendations. Further information can be obtained from the College upon request.

minimum of a "B" average and no more than one "C" in these four core courses. There is no foreign language requirement. The remaining courses are planned by the student and advisor according to the requirements of the program area in which the student wishes to specialize. 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 College upon request.

Upon completion of the thesis, the student must satisfactorily complete an oral examination, which is limited to a defense of the thesis. For students in the Clinical Psychology program, the oral examination committee must include the advisor and one additional Clinical Psychology faculty member. For students in the Industrial and Organizational Psychology program, the oral examination committee must include the advisor and two additional psychology faculty members: the advisor, and at least one additional committee member must be from the I/O program.

# Master of Science in Rehabilitation Counseling

60 credit hours Project

The Rehabilitation Counseling education program, fully accredited by the Council on Rehabilitation Education since 1975, is designed to educate the student to function as a rehabilitation counselor for persons with physical or mental disabilities who need psychosocial and vocational readjustment. The goal of rehabilitation is to help such persons realize their optimum level of vocational adjustment and independent living through the provision or coordination of evaluation, physical restoration, counseling, training, placement, and follow-up services. The demand for rehabilitation counselors has exceeded the supply in recent years, in public, private, nonprofit, and for-profit sectors.

A core of required graduate courses provides the basic knowledge and skills necessary to the field of rehabilitation. These include rehabilitation principles and practices, individual and group counseling, job placement, medical and psychosocial aspects of disability, vocational evaluation, and research methods.

Concurrently, field work of progressively increasing complexity takes place at a variety of rehabilitation facilities in the Chicago area. These include the state department of vocational rehabilitation, community rehabilitation facilities, rehabilitation centers, mental health centers, medical hospitals, and other facilities for persons with mental and physical disabilities. Within the program, two specialization tracks are available for interested students. The psychiatric rehabilitation track prepares students to work with persons with mental illness. The assistive technology track prepares students to use assistive technology and devices to help persons with disabilities in independent living and work accommodations.

The two-year 60-credit-hour program allows time for electives. A student entering with appropriate undergraduate courses and at least one year of work experience as a rehabilitation counselor may complete the degree in a minimum of 48 credit hours. Graduation requires successful completion of a research project. The comprehensive requirement is satisfied when the student completes the following courses with a "B average:

### **Required Courses**

- PSYC 410 Vocational Rehabilitation
- PSYC 411 Medical Aspects of Disabling Conditions
- PSYC 412 Multicultural and Psychosocial Aspects of Disability

PSYC 513 Assessment in Rehabilitation Counseling

- PSYC 523 Theories of Psychotherapy
- PSYC 549 Practicum in Rehabilitation Counseling

PSYC 557 Pre-Practicum in Rehabilitation Counseling

PSYC 561 Group Counseling

PSYC 562 Job Placement

PSYC 563 Human Growth and Career Development

PSYC 564 Rehabilitation Research Seminar

Other requirements include a rehabilitation internship (PSYC 578 or PSYC 579) and a research project (PSYC 594).

For professionals employed in community rehabilitation facilities and state agencies, and who want to pursue a M.S. in Rehabilitation Counseling degree or need it to maintain employment, there is a 48 credit hour parttime program designed to meet the needs of the working professional. The part-time program takes three years to complete and courses are offered in the evening and via distance education. The required fieldwork experiences (practicum and internship) are typically worked out with the student's place of employment. Applications for the program are received continuously with new students enrolled in a cohort beginning every three years.

Full and part-time students admitted to the program are eligible for Rehabilitation Services Administration (RSA) traineeships that cover the cost of tuition and a stipend for books and supplies. Traineeships are awarded on the basis of economic need and academic performance. The precise numbers of traineeships vary from year to year and cannot be guaranteed to any student at the time of acceptance in the program.

# **Doctor of Philosophy**

96 credit hours minimum Comprehensive exam Dissertation and oral defense Internship (for Clinical and Industrial/Organizational specializations)

A minimum of 96 credit hours beyond the bachelor's degree is required for the Ph.D. Individual specialties (e.g. Clinical) may require completion of additional courses. There is no foreign language requirement. Details concerning specific program requirements are available from the institute upon request.

### **Required Courses**

PSYC 545 Graduate Statistics I PSYC 546 Graduate Statistics II PSYC 691 Research and Thesis for the Ph.D. degree

# AND at least two of the following (chosen with advisor assistance):

PSYC 540 Research Methods PSYC 554 Survey of Multivariate Statistics PSYC 511 Psychometric Theory

# Required Courses (must be completed within two years after the sequence is started)

PSYC 501 Biological Bases of BehaviorPSYC 502 Social Bases of BehaviorPSYC 503 Learning, Cognition and MotivationPSYC 504 Individual and Cultural Differences

Students must complete the sequence with a minimum of a "B" average and no more than one "C" in these four courses. In addition, History and Systems of Psychology (PSYC 505), or completion of an equivalent course that must be shown on the students transcript, is required for students pursuing the Ph.D. in Clinical Psychology or Rehabilitation Counselor Education.

Written Ph.D. comprehensive examinations are held once each semester for the I/O program. Clinical students must schedule their oral comprehensive exam in consultation with their faculty advisor. These must be passed before students can register for dissertation credit hours. 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 thesis research, a student must present a thesis 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 thesis and conducted by a committee nominated by the college and appointed by the Dean of Graduate Studies.

The Ph.D. program with specialization in Clinical Psychology is accredited by the American Psychological Association. Completion typically requires six years of study beyond the bachelor's degree, including a oneyear 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 3 years of 15-20 hour/week practicum training that includes a wide variety of assessment and treatment experiences with a broad range of clients, including minority and underserved populations. Training sites include medical centers, community mental health centers, and clinics throughout the Chicago metropolitan area. Clinical supervision is provided both onsite and at IIT. All students complete an APA-accredited internship. The program prepares students to be license-eligible in the state of Illinois. Graduates typically function as practitioners and researchers in medical centers and multi-disciplinary clinical settings.

Students may elect to further specialize within the rehabilitation track. This specialization requires practica in a rehabilitation or behavioral medicine setting. In addition, students complete 15 hours of rehabilitation coursework and a master's project and dissertation related to rehabilitation or behavioral medicine. The development of a specialization within the rehabilitation track occurs in addition to the standard program of study in Clinical Psychology.

A Clinical Respecialization Certificate Program is offered for individuals with a Ph.D. in another area of psychology. The postdoctoral respecialization program provides the same core clinical training as the doctoral program. Completion typically takes three years, including one-year full-time internship. In recognition of the diverse previous experiences of participants, the program is tailored to the individual's specific training needs.

### Doctor of Philosophy (continued)

The Ph.D. program with specialization in Industrial and Organizational psychology includes coursework in both personnel and organizational psychology. Two semesters of internship in an organizational setting are usually required. Students in this program frequently are advised to supplement departmental offerings with selected courses in management, sociology, and law.

The Ph.D. program with specialization in Rehabilitation Counseling Education includes advanced seminars in adult career development and vocational behavior, professional and ethical issues, and psychosocial bases of disability and behavior, as well as practice in research, teaching, and supervision. Students can supplement their studies with electives focusing on psychiatric rehabilitation, rehabilitation administration, and organizational psychology or clinical psychology.

The Industrial/Organizational and Rehabilitation programs usually require three years of study beyond the masters degree. Further information on all programs is available from the College.

# **Special Fellowships**

Since its inception, the Rehabilitation Services Administration (RSA) of the U.S. Department of Education has continuously funded IIT's Rehabilitation Counselor Education programs. The RSA traineeships are designed to increase the number of practicing rehabilitation counselors 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 Institute 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. The College requires that students on assistantships apply for federal work study support.

# Bachelor of Science in Psychology/Master of Science in Personnel and Human Resources Development

For IIT undergraduate psychology majors it is possible to earn a master's degree in Personnel and Human Resources Development in 1.5 years instead of the normal 2 years. The regular master's program in Personnel and Human Resources Development requires 43 credit hours post bachelors, usually completed over the course of 2 years (see program description in this bulletin). However, IIT psychology majors who meet the criteria for regular admission to the master's program can consider completing their master's degree more quickly by smart use of their electives. In the senior year, qualified students can take graduate courses to meet their undergraduate elective requirements. For a class to be accepted towards the PHRD masters the student needs to obtain a grade of B or better. By taking psychology courses that also apply to the Personnel and Human Resources Development Program, students can reduce the graduate degree requirements by 13 credit hours. Interested students should submit a formal application to the PHRD program in the fall of their sophomore or junior year and work closely with the Head of the Industrial, Organizational, and Business Psychology Division and their undergraduate academic advisor throughout to ensure proper course sequencing.

The following courses are required for the M.S. degree in Personnel and Human Resources Development. They can be taken as part of required or elective courses for the B.S. degree in Psychology. If taken as an undergraduate, these courses do not have to be repeated for the graduate program. Students should also work closely with their undergraduate academic advisor to best plan a program leading to the combined degrees in the shortest possible time.

In the senior year, and in consultation with the Director of I/O Program, students may take the following courses:

PSYC 502 Social Bases of Behavior
PSYC 529 Personnel Selection*
PSYC 545 Graduate Statistics I*
PSYC 546 Graduate Statistics II*
PSYC 556 Organizational Psychology*
MBA 510 Financial and Managerial Accounting
MBA 560 Marketing

Courses noted * above need to be taken in the senior year in order to accelerate completion of the master's degree.

In the summer, after completion of the B.S., students will be eligible to complete their first required graduate internship. This needs to be coordinated during the senior year and prior to the summer with the Director of the I/O Program.

# Bachelor of Science in Psychology/Master of Science in Rehabilitation Counseling

For IIT undergraduate psychology majors it is possible to earn a master's degree in Rehabilitation Counseling in 1.5 years instead of the normal 2 years. The regular master's program in Rehabilitation Counseling requires 60 credit hours post bachelors usually completed over the course of 2 years (see program description in this bulletin). However, IIT psychology majors who meet the criteria for regular admission to the master's program can consider completing their master's degree more quickly by smart use of their electives. In the senior year, qualified students can take graduate courses to meet their undergraduate elective requirements. For a class to be accepted towards the Rehabilitation Counseling Master's the student needs to obtain a grade of B or better. By taking psychology courses that also apply to the Rehabilitation Counseling program, students can reduce the graduate degree requirements by 15 credit hours, or one full-time semester. Interested students should submit a formal application to the Rehabilitation Counseling Program in the fall of their sophomore or junior year and work closely with the Head of the Rehabilitation Division and their undergraduate academic advisor throughout to ensure proper course sequencing.

The following courses are required for the M.S. degree in Rehabilitation Counseling. They can be taken as part of required or elective courses for the B.S. degree in Psychology. If taken as an undergraduate, these courses do not have to be repeated for the graduate program. Students should also work closely with their undergraduate academic advisor to best plan a program leading to the combined degrees in the shortest possible time.

In the senior year, and in consultation with the Head of Rehabilitation Division, students may take the following courses:

PSYC 410 Vocational Rehabilitation

PSYC 411 Medical Aspects of Disabling Conditions

PSYC 412 Multicultural and Psychosocial Aspects of Disability

PSYC 513 Assessment in Rehabilitation Counseling

 $\operatorname{PSYC}$  523 Introduction to Theories of Psychotherapy

PSYC 557 Pre-Practicum in Rehabilitation Counseling PSYC 562 Job Placement

PSYC 563 Human Growth and Career Development

- PSYC 583 Rehabilitation Engineering Technology I
- PSYC 590 Psychiatric Rehabilitation

# **Certificate Programs**

#### **Compensation Management**

#### **Required Courses**

- ACC 510 Introductory Accounting (Stuart School of Business)
- $\operatorname{PSYC}$  710 Compensation and Benefits Application
- $\mathbf{PSYC}\ \mathbf{716}\ \mathbf{Base}\ \mathbf{Pay}\ \mathbf{Management}$
- PSYC 717 Variable Pay Programs
- PSYC 719 Fundamentals of Employee Benefits Programs

#### **Psychiatric Rehabilitation**

#### **Required Courses**

- PSYC 548 Vocational Psychiatric Rehabilitation PSYC 588 Psychiatric Rehabilitation II: Evidence-Based Practices in Mental Health
- $\operatorname{PSYC}$ 590 Psychiatric Rehabilitation

### **Rehabilitation Engineering Technology**

### Required courses

- PSYC 583 Rehabilitation Engineering Technology I
- PSYC 584 Rehabilitation Engineering Technology II
- PSYC 585 Rehabilitation Engineering Technology III

#### AND one of the following:

PSYC 556 Organizational Psychology PSYC 529 Personnel Selection and Evaluation

# **Course Descriptions**

Numbers in parentheses indicate class, lab and credit hours, respectively.

#### **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. Open only to Psychology majors. (3-0-3)

#### **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. (3-0-3)

#### (3-0-3)

### PSYC 503

#### Learning, Cognition & Motivation

Empirical and theoretical issues relating to learning, cognitive psychology, perceptual learning, drive and emotion will be surveyed. Emphasis will be placed on differing theoretical interpretations of a given set of data. (3-0-3)

#### PSYC 504

#### Individual & 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. (3-0-3)

# PSYC 505

### History & 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. (3-0-3)

### **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). (3-0-3)

(3-0-3)

### 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. Open only to Psychology majors.

Prerequisite(s): [(PSYC 506)] (3-0-3)

### PSYC 508

#### Ethics & 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. Open only to Psychology majors. (2-0-2)

### PSYC 509

#### Ethics & 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. Open only to Psychology majors. (1-0-1)

#### (1-0-1

# 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. (3-0-3)

# PSYC 511

### Psychometric Theory

Basic understanding of principles and theories of psychological measurement emphasizing (1) theories and methods for estimation of reliability and validity, (2) techniques for the measurement of psychological variables and (3), methods for construction of psychological and educational measuring instruments.

Prerequisite(s): [(PSYC 545 and PSYC 546)] (3-0-3)

### 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. Open only to Psychology majors. Prerequisite(s): [(PSYC 510)] (3-0-3)

### PSYC 513

#### Assessment in Rehabilitation Counseling

An orientation to the process and practice of assessing adults with disabling conditions for rehabilitation plan development and vocational decision-making. Introduction to test selection, administration, and interpretation through synthesis, integration, and evaluation of vocational assessment data used in rehabilitation counseling. Open only to Psychology majors.

(3-0-3)

#### PSYC 514

# Vocational Evaluation II: Report Development & 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. Open only to Psychology majors. Prerequisite(s): [(PSYC 513)] (3-0-3)

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. Open only to Psychology majors.

(3-0-3)

#### **PSYC 517**

#### Performance Appraisal Seminar

The objectives of the seminar are to 1) provide a broad understanding of the multiple facets of performance appraisal, 2) understand research and advances in the field, and 3) understand the challenges and pitfalls of successfully implementing a PA system in an organization. Prerequisite(s): [(PSYC 529 and PSYC 556)]

(3-0-3)

### **PSYC 518**

#### Basic Clinical Skills

This course covers introductory therapy skills including intake, suicide assessment, case formulation, and differential diagnosis.

Prerequisite(s): [(PSYC 526)] (1-0-1)

### **PSYC 519**

#### Therapy I-A

Basics of conducting cognitive behavioral therapy following PSYC 518 (Basic Clinical Skills). Prerequisite(s): [(PSYC 518)]

(2-0-2)

### 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. Open only to Psychology majors. (3-0-3)

#### **PSYC 523**

#### Introduction to Theories of Psychotherapy

Introduction to various approaches to the rapeutic intervention. The conceptual bases, history, methods, empirical foundations and applicability of important schools of the rapeutic intervention will be considered. (3-0-3)

#### **PSYC 524**

#### Assessment & Treatment of Infants & 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. Open only to Psychology majors. (3-0-3)

# PSYC 525

### Psychopathology

This course covers theory and research on developmental processes and their functions to promote health and as risk factors for psychopathology. Open only to Psychology majors. (3-0-3)

(0-0-0)

# PSYC 526

#### Psychopathology

Critical examination of clinical and experimental research in psychopathology and diagnostic classification systems. Open only to Psychology majors. (3-0-3)

(3-0-3

### PSYC 529

#### Personnel Selection & Evaluation

Principles and techniques of employee selection and placement. Analysis of test data which will maximize the effectiveness of such techniques. Open only to Psychology majors. (3-0-3)

#### PSYC 530

#### Contemporary Issues in Industrial Organizational Psychology

Survey of major theoretical formulations and current approaches to intervention techniques in the field of industrialorganizational psychology. Open only to Psychology majors. Prerequisite(s): [(PSYC 529 and PSYC 556)] (3-0-3)

#### **PSYC 531**

#### **Organizational Attitudes & 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. Open only to Psychology majors.

Prerequisite(s): [(PSYC 556)] (3-0-3)

#### 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. (3-0-3)

#### 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)] (3-0-3)

#### 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)] (3-0-3)

### 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. (3-0-3)

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### PSYC 538

### Psychology of Sport, Performance, & 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. (3-0-3)

#### 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. (3-0-3)

#### **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. (3-0-3)

#### PSYC 546

#### Graduate Statistics II

Statistical procedures used in the prediction and explanation of psychological data, including multiple regression. Emphasis on computer applications. Open only to Psychology majors. Prerequisite(s): [(PSYC 545)] (3-0-3)

# 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.

(3-0-3)

#### PSYC 549

#### Practicum in Rehabilitation Counseling

Seminar and supervised experience in rehabilitation counseling. Working two days in a rehabilitation facility and carrying a small client caseload geared toward the development of individual counseling skills. (Credit: Variable)

Prerequisite(s): [(PSYC 410, PSYC 523, and PSYC 557)] (Credit: Variable)

### PSYC 550

#### Couples Research & 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. Open only to Psychology majors. (3-0-3)

### 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)]

(3-0-3)

### PSYC 553

### Family & Couples Therapy

Surveys the major theoretical perspectives for understanding and intervening with family and marital problems. Open only to Psychology majors. (3-0-3)

PSYC 554

### Survey of Multivariate Statistics

Introduction to the major multivariate statistical procedures used in psychology; factor analysis, discriminant analysis, multivariate analysis of variance and canonical correlation. Prerequisite(s): [(PSYC 545) OR (PSYC 546)] (3-0-3)

#### 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. Open only to Psychology majors.

Prerequisite(s): [(PSYC 529 and PSYC 556)] (3-0-3)

#### PSYC 556

#### Organizational Psychology

Theory and research concerning human behavior in formal organizations, communication nets, dynamics of managerial jobs; current ideas concerning organizations. (3-0-3)

#### PSYC 557

#### Pre Practicum in Rehabilitation Counseling

Seminar and observation at community rehabilitation facilities. Study of interviewing techniques, orientation to rehabilitation programs and field activities at rehabilitation agencies. (3-0-3)

# PSYC 558

### Industrial Psychology Internship I

Supervised experience in psychological practices in an industrial setting. (Credit: variable) (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

Methods and techniques of various procedures in the counseling process. Advantages, limitations and unique applications of various approaches with specific client populations.

Prerequisite(s): [(PSYC 523*)] An asterisk (*) designates a course which may be taken concurrently. (3-0-3)

### 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. (3-0-3)

#### **PSYC 563**

#### Human Growth & Career Development

Presentation and discussion of human growth and career development theories across life span with special emphasis on persons with disabilities. Specific content includes Erickson's psychosocial development, Super's life span theory, Holland's theory of types, Trait-factor Theory, Krumboltz's social learning approach, Tiedeman's spiritual perspective in career decision making, and family and system influences on vocational choice. Open only to Psychology majors. (3-0-3)

#### **PSYC 564**

#### **Rehabilitation Research Seminar**

The primary objective of this course is to help students become familiar with rehabilitation 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 research. Specifically, this course covers an overview of various research designs, data analysis techniques and the use of SPSS for statistical analysis. (3-0-3)

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#### PSYC 566 Addictive Behaviors

A review of theoretical models of addiction from sociological, biological, and psychological perspectives. Critical examination of research methodology and clinical approaches. Emphasis on alcohol and drug abuse. Also covers substance abuse in special populations and other addictive behaviors. Open only to Psychology majors.

(3-0-3)

#### **PSYC 571**

### Seminar in Quantitative Psychology

Presentation and discussion of advanced topics in quantitative psychology. Specific content will vary from year to year. Topics such as factor analysis, multidimensional scaling, etc., will be discussed. May be taken more than once. Instructor permission required.

Prerequisite(s): [(PSYC 554)] (3-0-3)

#### **PSYC 573**

#### Psychosocial Bases: Disability & 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

(3-0-3)

#### PSYC 575

#### Adult Career Development & 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. (3-0-3)

#### **PSYC 577**

# Professional & Ethical Issues in Rehabilitation Counseling Psychology

Presentation and discussion of issues related to professional and ethical practice in rehabilitation counseling psychology. History and philosophy of rehabilitation, professional and ethical standards, concerns in rehabilitation assessment, counseling, placement and independent living. Instructor permission required. Open only to Psychology majors. (3-0-3)

#### PSYC 578

#### Rehabilitation Internship I

Supervised experience in rehabilitation counseling. (Credit: Variable)

Prerequisite(s): [(PSYC 549)] (Credit: Variable)

### PSYC 579

Rehabilitation Internship II Supervised experience in rehabilitation counseling. (Credit: variable)

Prerequisite(s): [(PSYC 549)] (Credit: Variable)

#### **PSYC 580**

#### Seminar in Leadership

Reviews models and theories of leadership that cover group dynamics, power, influence, and conflict management as well as issues of diversity and gender. The focus is on research and practical issues in understanding leadership and its effectiveness. Requires certification as K-12 teacher or approval of instructor.

Prerequisite(s): [(PSYC 556)] (3-0-3)

#### **PSYC 581**

#### Neuropsychologicial Assessment

Seminar in neuropsychological assessment. A review of neuroanatomy followed with a review of the conceptual foundations of brain-behavior relationships. Major assessment instruments will be covered. (3-0-3)

#### **PSYC 582**

#### Applied Psycholphysiology & Biofeedback

Reviews applications of physiological measures to practical problems. Clinical applications of biofeedback are discussed and demonstrated. Special emphasis on electromyographic techniques. Open only to Psychology majors. (3-0-3)

#### **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. Open only to Psychology majors. (3-0-3)

#### **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. Open only to Psychology majors.

Prerequisite(s): [(PSYC 583)] (3-0-3)

#### PSYC 585

#### Rehabilitation Engineering Technology III

Seminar designed to accompany and enhance practical RET experiences, such as concurrent internship, employment or approved projects involving RET/AT applications. Case presentations of technology for independent living, issues of quality of outcome, alternatives/appropriateness of technology solutions, ethics, emotional aspects of technology acquisition, independence/dependency and barriers to acquiring and deployment of AT are discussed. Prerequisite(s): [(PSYC 583 and PSYC 584)]

(3-0-3)

#### **PSYC 586**

#### **Concepts of Supervision**

Explores formulations of the supervisory relationship and critical issues in the supervision of clinicians. (3-0-3)

#### **PSYC 588**

#### Graduate Psychology Seminar

Reports and discussion of current problems and issues in psychology. (3-0-3)

(3-0-3)

# PSYC 589

Rehabilitation Internship III Supervised experience in rehabilitation counseling. (Credit: Variable) Prerequisite(s): [(PSYC 549)] (Credit: Variable)

#### **PSYC 590**

#### **Psychiatric Rehabilitation**

Class covers a wide range of topics including a review of the disease and disability models of mental illness, skills training components in treatment, incentive strategies for participants, transfer of learned skills to other situations, and cognitive rehabilitation strategies. Open only to Psychology majors. (3-0-3)

# PSYC 591

### Research & Thesis M.S.

Instructor permission required. (Credit: Variable)

#### **PSYC 594**

**Special Projects** 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. (0-0-1)

#### **PSYC 600**

#### **Continuation of Residency**

Continuation of residency. (0-0-1)

#### PSYC 691

#### Research & Thesis Ph.D.

Research and thesis for Ph. D. students. (Credit: Variable)

#### PSYC 710

#### Compensation & Benefit Application

Compensation and benefit application. Open only to Psychology majors. (1.5-0-1.5)

### 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. Open only to Psychology majors. (3-0-1.5)

# **PSYC** 712

#### Bayley Scales of Infant Development

Bayley Scales of Infant Development. Open only to Psychology majors. (3-0-1)

### 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. (1.5-0-1.5)

#### **PSYC** 715

#### **Organizational Assessment & 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. Open only to Psychology majors. (1.5-0-1.5)

#### **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. Open only to Psychology majors.

(1.5-0-1.5)

#### PSYC 717 Variable Pay P

# Variable Pay Programs

This course provides an in-depth review of variable pay programs within organizations, including incentives, recognition programs and team-based pay. Organizationwide, organizational unit, and individual programs will be discussed in terms of plan design, implementation and evaluation. Open only to Psychology majors. (1.5-0-1.5)

#### **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. Open only to Psychology majors. (1.5-0-1.5)

#### **PSYC 720**

#### Individual Assessment for Industrial/Organizational Psychology

This course is designed to teach students how to assess individuals for hire, promotion, and development. Students will develop a testing protocol including a structured interview, cognitive ability, and personality testing. The course will provide applied experience conducing assessments of executives who have volunteered to serve as testing subjects. Interviewing skill, test interpretation, and report writing are the primary learning objectives of the course. (1,5-0-1,5)

#### **PSYC 721**

#### **Network Analysis**

Network analyses focuses on relationships between social entities (e.g. individuals, groups, businesses) and has been used in a number of fields including the social and behavioral sciences. The primary focus will center on social network analysis, which has been developed from an interdisciplinary approach from sociology, psychology, and economics. This course will present an introduction to various methods and concepts of social network analysis including applications in the social and behavioral sciences using these methods. Topics include, but are not limited to, graph theory, properties of individuals, subgroups/cliques, blockmodels, and dyad/triad analysis. An introduction to network models and applications in common software programs will also be given. Prerequisite(s): [(PSYC 545 and PSYC 546)]

(1.5-0-1.5)

#### **PSYC 782**

#### Assitive Technology for Counselors

Intensive one-week overview of Assistive Technology with a focus on vocational applications. Includes visitations to working assistive technology sites, and lectures by consumers and specialists (including several of national prominence) in various areas of AT. Instructor permission required. Open only to Psychology majors.

(1.5 - 0 - 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. Open only to Psychology majors. (1.5-0-1.5)

#### **Undergraduate Courses Available to Graduate Students**

Note: Students may take up to an approved number of the following courses.

PSYC 406 History and Systems of Psychology

PSYC 409 Psychological Testing

PSYC 410 Vocational Rehabilitation

PSYC 411 Medical Aspects of Disabling Conditions

PSYC 412 Multicultural and Psychosocial Aspects of Disability

PSYC 414 Physiological Psychology

PSYC 420 Single Subject Design and Applied Behavior Analysis

PSYC 426 Cognitive Processes

PSYC 431 Measurement of Attitudes

PSYC 435 Early Development

PSYC 436 Adult Development

PSYC 449 Practicum in Rehabilitation Services

PSYC 452 Personality Theory

PSYC 456 Engineering Psychology

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#### Train

Metra Rail Rock Island District line to 35th Street/Lou Jones/Bronzeville station.

Other commuter railroad lines to Union and Northwestern train stations (both off Canal Street), then public transportation, taxi, or IIT shuttle bus from the Downtown Campus at 565 West Adams Street to Main Campus.

#### Bus

To Greyhound or Continental Trailways terminal, then taxi or public transportation to IIT.

#### **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

Metered parking is available to all visitors and 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. 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 www.iit.edu/~parking. Please call the parking administrator at 312.567.8968 if you need assistance in finding parking.



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