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

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

**Research Centers and Institutes**

**Center for Electrochemical Science and Engineering**  
Jai Prakash, Director

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

**Engineering Center for Diabetes Research and Education**  
Ali Cinar, Director

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

**Center for Complex Systems and Dynamics**  
Fouad Teymour, Director

**Wanger Institute for Sustainable Energy Research**  
Hamid Arastapoor, Director

**Research Facilities**

Research facilities of the department include:

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

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

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

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

Energy and Sustainability
Fuel cells and batteries
Fluidization and gasification
Hybrid systems

Biological Engineering
Molecular modeling
Diabetes
Biomedical and pharmaceutical engineering
Biochemical engineering
Food processing

Advanced Materials
Interfacial and transport phenomena
Nanotechnology
Polymers
Biomaterials

Systems Engineering
Complex systems
Advanced process control
Process monitoring

Energy/Environment/Economics (E3)
Faculty Adviser
Chemical and Biological Engineering
Javad Abbasian
127 Perlstein Hall
10 W. 33rd St.
Chicago, IL 60616
312.567.3047
abbasian@iit.edu

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

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

**Admission Requirements**

**Minimum Cumulative Undergraduate GPA**
3.0/4.0

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

**Minimum TOEFL Scores**
80/213/550 (internet-based/computer-based/paper-based test scores)

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

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

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

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

**Degree Programs**
- Master of Biological Engineering
- Master of Chemical Engineering
- Master of Science in Chemical Engineering
- Doctor of Philosophy in Chemical Engineering

**Dual Degree Program**
- Master of Science in Computer Science/Master of Chemical Engineering (with Computer Science)

**Interdisciplinary Programs**
- Master of Chemical Engineering with Specialization in Energy/Environment/Economics (E3)
- Master of Science in Chemical Engineering with Specialization in Energy/Environment/Economics (E3)
- Doctor of Philosophy of Chemical Engineering with Specialization in Energy/Environment/Economics (E3)
Certificate Programs

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

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

- Biological Engineering
- Current Energy Issues
- Particle Processing
- Pharmaceutical Engineering
- Polymer Science and Engineering
- Process Operations Management
Course Descriptions

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

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

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

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

CHE 525
Chemical Reaction Engineering
Prerequisite(s): CHE 423
Lecture: 3 Lab: 0 Credits: 3

CHE 530
Advanced Process Control
Prerequisite(s): CHE 435
Lecture: 3 Lab: 0 Credits: 3

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

CHE 536
Computational Techniques in Engineering
Lecture: 3 Lab: 0 Credits: 3

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

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

CHE 542
Fluidization and Gas-Solids Flow Systems
Prerequisite(s): CHE 535
Lecture: 3 Lab: 0 Credits: 3
CHE 543
Energy, Environment, and Economics
The linkage of energy, environmental and economic issues. The impact of energy supply and end use on human well-being and the ecosystem. A comprehensive approach to the resolution of resource, technical, economic, strategic, environmental, social and geopolitical problems of the energy industries. Pathways to a sustainable global energy system.
Lecture: 3 Lab: 0 Credits: 3

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

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

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

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

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

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

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

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

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

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

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

CHE 582
Interfacial and Colloidal Phenomena with Applications
Applications of the basic principles of physical chemistry, surfactants and interfacial phenomena, surface and interfacial tension, adsorption of surfactants from solutions, spreading, contact angles, wetting, electro kinetic phenomena, rheology, dynamic interfacial properties, mass transport across interfaces. Applications include emulsions, foams, dispersions, tribology, detergency, flotation, enhanced oil recovery, suspension, emulsion polymerization and liquid membranes.
Prerequisite(s): (CHE 351 or CHE 451) and CHE 406
Lecture: 3 Lab: 0 Credits: 3
CHE 583
Pharmaceutical Engineering
Lecture: 3 Lab: 0 Credits: 3

CHE 584
Tissue Engineering
Lecture: 3 Lab: 0 Credits: 3

CHE 585
Drug Delivery
Lecture: 3 Lab: 0 Credits: 3

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

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

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

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

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

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

ENGR 595
Product Development for Entrepreneurs
Elements of product development (mechanical and electrical), manufacturing and production planning, supply chain, marketing, product research, and entrepreneurship concepts are taught in this class. In this course, student teams will be required to create a compelling product that has potential to be sold in today’s marketplace. They will be required to create functional prototypes of their product for people to use and critique. If successful, students will be allowed to put their product on Kickstarter.com and take orders for delivery after the class is complete while potentially fostering their own business as a result of this course.
Lecture: 3 Lab: 0 Credits: 3

ENGR 596
Practical Engineering Training
This course is a mentored, immersive practical engineering training. Students learn under the direction of professional engineers and practicing engineers by working on real engineering projects. The student will perform hands-on engineering, including learning and developing/applying engineering principles and concepts to complete the project assigned to the student. The student will apply engineering ethics and safety during their practical engineering training. Students will communicate the results of their work in written and oral communications. Students will receive assignments of varying complexity consistent with their graduate standing.
Lecture: 0 Lab: 9 Credits: 3

ENGR 598
Technological Entrepreneurship in Drug Development: Pharmaceutical Entrepreneurship
This course will give students an understanding of what is involved in technology commercialization, development of a business plan, and understand/experience what it is like working for a startup company by working on a real life project. Students from various educational fields (engineering, business, biology, chemistry, industrial technology/management) are welcome to be a part of a cross functional team that will participate in the National Institute of Health (NIH) Startup Challenge Business Plan Competition. Students will understand how to translate an idea to a business and also experience what it is like to work in a startup company in the field of engineering, science, and technology. Students will also gain an understanding of what it takes to bring a drug to the market. Furthermore, students will get the opportunity to obtain guidance on the business from expert advisors from the pharmaceutical industry, entrepreneurs, and venture capitalists. Permission of the instructor is required.
Lecture: 3 Lab: 0 Credits: 3

ENGR 599
Graduate Research Immersion: Individual
This course provides a faculty-mentored immersive research experience. Research topics are determined by the faculty mentor’s area of research. In addition to the mentored research, students participate in seminars, prepare a written report of their research findings, and present their research findings at a poster expo.
Lecture: 3 Lab: 0 Credits: 3