

# CHEMICAL AND BIOLOGICAL ENGINEERING

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## Chair

Sohail Murad

## Faculty with Research Interests

For information regarding faculty visit the Department of Chemical and Biological Engineering website.

The department offers leading edge research and education programs in chemical engineering and biological engineering. These programs are aimed to prepare engineers for the technological challenges of the 21st century by providing students with:

- Fundamental knowledge and design capability in chemical, biological, and environmental engineering, food process engineering, and pharmaceutical engineering
- Advanced research programs in core competency areas
- Understanding of ethical, economic, and social issues that influence technology choices
- Leadership and communication skills
- Life-long learning capabilities

The objective of the undergraduate program is to educate chemical engineering students and prepare them for careers in professional practice and/or for advanced studies at the graduate level. The program specifically aims to develop a new breed of engineers who are not only well schooled in the basics and fundamentals of chemical and biological engineering, but who also possess the skills necessary for success in today's workplace. In recognition of the recent shift of the chemical engineering profession into a more prominent involvement in biotechnology and biological engineering, the department has redesigned the undergraduate curriculum in order to ensure that its graduates will possess additional knowledge and skills in biology and biological engineering as predicated by the changing needs of industry.

## Degree Programs

- Bachelor of Science in Chemical Engineering

## Co-Terminal Options

The Department of Chemical and Biological Engineering also offers the following co-terminal degrees, which enables a student to simultaneously complete both an undergraduate and graduate degree in as few as five years:

- Bachelor of Science in Biomedical Engineering/Master of Chemical Engineering
- Bachelor of Science in Chemical Engineering/Master of Biological Engineering
- Bachelor of Science in Chemical Engineering/Master of Chemical Engineering
- Bachelor of Science in Chemical Engineering/Master of Engineering in Environmental Engineering
- Bachelor of Science in Chemical Engineering/Master of Food Process Engineering

These co-terminal degrees allow students to gain greater knowledge in specialized areas while, in most cases, completing a smaller number of credit hours with increased scheduling flexibility. For more information, please visit the Department of Chemical and Biological Engineering website ([engineering.iit.edu/chbe](http://engineering.iit.edu/chbe)).

## Other Degree Programs in Chemical and Biological Engineering

B.S., M.S., professional master's, and Ph.D. degree programs are offered in chemical engineering. A professional master's degree is offered in biological engineering. M.S. and professional master's degree programs are also offered in chemical engineering/computer science. The department also offers a B.S./M.D. program in engineering and medicine and a combined undergraduate/graduate law program.

## Minor

- Minor in Polymer Science and Engineering

## Course Descriptions

### CHE 100

#### Introduction to the Profession I

Introduction to chemical engineering and engineering productivity software. Communication skills development, technical reporting and presentation, engineering ethics, and a variety of topics are discussed.

**Lecture: 1 Lab: 2 Credits: 2**

**Satisfies:** Communications (C)

### CHE 101

#### Introduction to the Profession II

A continuation of CHE 100. Advanced engineering applications of productivity software. Engineering graphics and technical flow sheeting. Team project research and project management skills. Internet publishing.

**Prerequisite(s):** CHE 100

**Lecture: 1 Lab: 2 Credits: 2**

**Satisfies:** Communications (C)

### CHE 202

#### Material Energy Balances

Material and energy balances for engineering systems subjected to chemical and physical transformations. Calculations on industrial processes.

**Prerequisite(s):** (MATH 152 and CHEM 125 and CS 105\*) or CS 115\* or CS 104\*, An asterisk (\*) designates a course which may be taken concurrently.

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

**Satisfies:** Communications (C)

### CHE 239

#### Mathematical and Computational Methods

Utilization of numeric and analytic methods to find solutions to a variety of chemical engineering problems. Emphasis placed on development of computer code, and interpretation of results. Topics covered include systems of algebraic equations, initial value differential equations, and boundary value differential equations.

**Prerequisite(s):** CHE 202 and MATH 252\* and CHE 301\*, An asterisk (\*) designates a course which may be taken concurrently.

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

### CHE 301

#### Fluid Mechanics

Flow of fluids. Fundamentals of fluid flow design equations as applied to selected unit operations.

**Prerequisite(s):** MATH 252 and CHE 202

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

### CHE 302

#### Heat and Mass Transfer Operations

Fundamentals of heat and mass transfer. Heat and mass transfer design equations as applied to selected unit operations. Mass transfer in stage-wise and continuous contacting equipment. Unsteady state operations in mass transfer equipment.

**Prerequisite(s):** CHE 301\*, An asterisk (\*) designates a course which may be taken concurrently.

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

### CHE 311

#### Foundations of Biological Science for Engineering

This introductory course will introduce engineering students to basic principles of Biological Sciences, which will enable them to understand more advanced courses on the topic and provide a solid base for further study in all life sciences-related topics required in their individual programs.

**Prerequisite(s):** CHEM 125

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

### CHE 317

#### Chemical and Biological Engineering Laboratory I

Laboratory work in the unit operations of chemical engineering, fluid flow, heat transfer, and other selected topics.

**Prerequisite(s):** CHE 301

**Lecture: 1 Lab: 3 Credits: 2**

**Satisfies:** Communications (C)

### CHE 351

#### Thermodynamics I

Laws of thermodynamics and their application to chemical engineering operations.

**Prerequisite(s):** CHE 202\* and CHEM 343\*, An asterisk (\*) designates a course which may be taken concurrently.

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

### CHE 406

#### Transport Phenomena

The equations of change in different coordinate systems (mass, momentum, and energy transport). Velocity distribution in laminar and turbulent flow. Formulation and analytical solutions to the problems of viscous flow, molecular diffusion, heat conduction and convection.

**Prerequisite(s):** (CHE 301 and CHE 302 and MATH 252) or Graduate standing

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

### CHE 412

#### Foundations of Biological Science for Engineering

This introductory course will introduce graduate engineering students to basic principles of Biological Sciences, which will enable them to understand more advanced courses on the topic and provide a solid base for further study in all life sciences-related topics required in their individual programs.

**Prerequisite(s):** CHEM 125 or Graduate standing

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

### CHE 416

#### 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 418****Chemical and Biological Engineering Laboratory II**

Laboratory work in distillation, humidification, drying, gas absorption, filtration, and other areas.

**Prerequisite(s):** CHE 317 and CHE 302

**Lecture:** 1 **Lab:** 3 **Credits:** 2

**Satisfies:** Communications (C)

**CHE 423****Chemical Reaction Engineering**

Introduction to the fundamentals of chemical kinetics. The design, comparison, and economic evaluation of chemical reactors. Emphasis on homogeneous systems.

**Prerequisite(s):** (CHE 302 and CHE 351 and CHE 433) or Graduate standing

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

**CHE 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, and introduction to multivariate analysis.

**Prerequisite(s):** MATH 151 or Graduate standing

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

**CHE 433****Process Modeling and System Theory**

Principles of process modeling. Modeling of non-reactive and reactive dynamic processes. Transfer functions. Modeling of multistage and non-linear processes. Discrete-event processes, Markov processes, and automata theory.

**Prerequisite(s):** (CHE 302 and CHE 351) or Graduate standing

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

**CHE 435****Process Control**

Dynamic process models, stability assessment, feedback, and feed forward control strategies, design and tuning of closed-loop controllers, time domain and frequency domain design and performance assessment methods. Multivariable systems, interaction, multi-loop control. Software for process simulation and controller design.

**Prerequisite(s):** (CHE 302 and CHE 433) or Graduate standing

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

**CHE 439****Numerical and Data Analysis**

Utilization of numerical methods to find solutions to a variety of chemical engineering problems. Emphasis placed on problem formulation, development of computer code, and interpretation of results. Techniques covered include: systems of algebraic equations, linear regression, and statistics. Numerical differentiation and integration, solution of ordinary and partial differential equations.

**Prerequisite(s):** (CHE 301 and MATH 252\* and CHE 202) or Graduate standing, An asterisk (\*) designates a course which may be taken concurrently.

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

**CHE 451****Thermodynamics II**

Second law analysis of cooling, separation, combustion, and other chemical processes. Chemical reaction equilibrium and processing applications.

**Prerequisite(s):** CHE 351 or Graduate standing

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

**CHE 455****Polymer Processing**

Considerations of transport processes in the polymer industry. Analysis of heat, mass, and momentum transfer in molten polymers and polymer solutions. The polymer flow processes to be discussed will include: extrusion, calendaring, fiber spinning, injection molding, mixing, and polymerization reaction.

**Prerequisite(s):** (CHE 301 and CHE 302) or Graduate standing

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

**CHE 465****Electrochemical Energy Conversion**

Thermodynamics, kinetic and mass-transfer fundamentals of electrochemical devices. Potential and potential measurement. Batteries and fuel cells. Fundamentals of corrosion and corrosion prevention.

**Prerequisite(s):** CHE 302 or Graduate standing

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

**CHE 467****Fuel Cell System Design**

System or chemical reactor perspective of fuel cell design. Macro-scale modeling of fuel cell applications. Description of electrode/electrolyte assemblies and the three phase region, polarization curve characterization, analysis of continuous flow systems, typical fuel cell stack configurations, analysis of spatial non-uniformities in stacks, and balance of plant design.

**Prerequisite(s):** CHE 423 or Graduate standing

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

**CHE 470****Introduction to Polymer Science**

An introduction to the basic principles that govern the synthesis, processing and properties of polymeric materials. Topics include classifications, synthesis methods, physical and chemical behavior, characterization methods, processing technologies and applications. Same as CHEM 470 and MMAE 470.

**Prerequisite(s):** (CHEM 122 and CHEM 123) or CHEM 124 or (MATH 251 and CHEM 125 and PHYS 221) or Graduate standing

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

**CHE 489****Fluidization**

Regimes of fluidized beds, rheology behavior of fluidized beds, particle classification, properties of the bubble, emulsion, elutriation, and jet. Fluid mechanic theory and heat and mass transfer in fluidized beds. Design aspects of fluidized beds and pneumatic conveying. Industrial applications of fluidized beds (catalytic reactors, drying, coal conversion, waste treatment).

**Prerequisite(s):** CHE 302 or Graduate standing

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

#### **CHE 491**

##### **Undergraduate Research**

Students undertake an independent research project under the guidance of a chemical and biological engineering faculty member.

**Credit:** Variable

#### **CHE 494**

##### **Process Design I**

Introduction to design techniques and economic aspects of chemical processes. The technical and economic aspects of equipment selection and design, and alternative methods of operation.

**Prerequisite(s):** CHE 423\* and CHE 435\* and CHE 451 and CHE 433, An asterisk (\*) designates a course which may be taken concurrently.

**Lecture: 2 Lab: 3 Credits: 3**

**Satisfies:** Communications (C)

#### **CHE 496**

##### **Process Design II**

Group project in process design. Integration of technical, safety, environmental, economic, and societal issues in process development and design. Final part of the IPRO project package. Project teams consist of chemical engineering students and students from other disciplines and professions. Students from other academic units should register for designated section of IPRO 497 (three credits) and their contribution to the project tasks will be defined accordingly.

**Prerequisite(s):** (CHE 494 and CHE 423\* and CHE 435\*) or Graduate standing, An asterisk (\*) designates a course which may be taken concurrently.

**Lecture: 2 Lab: 2 Credits: 3**

**Satisfies:** Communications (C)

#### **CHE 497**

##### **Special Projects**

Special projects.

**Credit:** Variable

#### **CHE 498**

##### **Chemical Process Safety Design**

The purpose of the course is to apply process design disciplines to integrate safety as a principal of the design process. Typical subjects are: thermodynamics of explosions, identification of process hazards, chemical reactivity hazards, dispersion models of release of toxic materials, fires and fire protection, and HAZOP and Fault Tree analysis.

**Prerequisite(s):** CHE 494 or Graduate standing

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