

# CHEMICAL ENGINEERING, BSE

**Degree:** Bachelor of Science in Engineering (BSE)

**Major:** Chemical Engineering

## Program Overview

The Bachelor of Science in Engineering degree program with a major in Chemical Engineering is accredited by the Engineering Accreditation Commission of ABET, under the commission's General Criteria and Program Criteria for Chemical, Biochemical, Biomolecular, and Similarly Named Engineering Programs.

## Program Educational Objectives

The undergraduate program in chemical engineering seeks to produce graduates who will:

- apply the knowledge, skills and ethical practice acquired through the chemical engineering curriculum to positively contribute to their profession and society
- assume and excel in positions of responsibility and/or leadership in academia, industry, government, and business
- succeed in post-graduate and professional degree programs

## Learning Outcomes

In preparation for achieving the above educational objectives, the Bachelor of Science in Engineering degree program with a major in Chemical Engineering is designed so that students attain:

- an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
- an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
- an ability to communicate effectively with a range of audiences
- an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
- an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
- an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
- an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

## Co-op and Internship Programs

Opportunities are available for students to alternate studies with work in industry or government as a co-op student, which involves paid full-time employment over seven months (one semester and one summer). Students may work in one or two co-ops, beginning in the third year of study. Co-ops provide students the opportunity to gain valuable hands-

on experience in their field by completing a significant engineering project while receiving professional mentoring. During a co-op placement, students do not pay tuition but maintain their full-time student status while earning a salary. Alternatively or additionally, students may obtain employment as summer interns.

## Undergraduate Policies

For undergraduate policies and procedures, please review the Undergraduate Academics section of the General Bulletin.

## Accelerated Master's Programs

Undergraduate students may participate in accelerated programs toward graduate or professional degrees. For more information and details of the policies and procedures related to accelerated studies, please visit the Undergraduate Academics section of the General Bulletin.

## Program Requirements

Students seeking to complete this major and degree program must meet the general requirements for bachelor's degrees and the Unified General Education Requirements. Students completing this program as a secondary major while completing another undergraduate degree program do not need to satisfy the school-specific requirements associated with this major.

Code	Title	Credit Hours
<b>Required Mathematics, Science and Engineering courses</b>		
MATH 121	Calculus for Science and Engineering I	4
MATH 122	Calculus for Science and Engineering II	4
or MATH 124	Calculus II	
MATH 223	Calculus for Science and Engineering III	3
or MATH 227	Calculus III	
MATH 224	Elementary Differential Equations	3
or MATH 228	Differential Equations	
PHYS 121	General Physics I - Mechanics	4
or PHYS 123	Physics and Frontiers I - Mechanics	
PHYS 122	General Physics II - Electricity and Magnetism	4
or PHYS 124	Physics and Frontiers II - Electricity and Magnetism	
CHEM 111	Principles of Chemistry for Engineers	4
ECHE 225	Thermal and Fluid Sciences	4
ENGR 130	Foundations of Engineering and Programming	3
ENGR 145	Chemistry of Materials	4
ENGR 210	Introduction to Circuits and Instrumentation	4
ENGR 399	Impact of Engineering on Society	3

Code	Title	Credit Hours
<b>Major Required Courses:</b>		
ECHE 151	Introduction to Chemical Engineering at Case	1
ECHE 260	Introduction to Chemical Systems	3
ECHE 360	Transport Phenomena for Chemical Systems	4
ECHE 361	Separation Processes	4
ECHE 362	Chemical Engineering Laboratory	4
ECHE 363	Thermodynamics of Chemical Systems	4
ECHE 364	Chemical Reaction Processes	4
ECHE 365	Measurements Laboratory	3

ECHE 367	Process Control	4
ECHE 398	Process Analysis, Design and Safety	4
ECHE 399	Chemical Engineering Design Project	3

**Related Required Courses:**

CHEM 290	Chemical Laboratory Methods for Engineers	3-4
or CHEM 233 & CHEM 234	Introductory Organic Chemistry Laboratory I and Introductory Organic Chemistry Laboratory II	
CHEM 223	Introductory Organic Chemistry I	3
or CHEM 323	Organic Chemistry I	
ECHE 313	Statistical Analysis of Chemical Processes	3
or STAT 312	Basic Statistics for Engineering and Science	
or STAT 313	Statistics for Experimenters	
Science/Engineering Elective		3
<i>Choose one of the following:</i>		3
CHEM 224	Introductory Organic Chemistry II	
EMAC 270	Introduction to Polymer Science and Engineering	
EMAC 276	Polymer Properties and Design	
EMSE 276	Materials Properties: Composition and Structure	
PHYS 221	Introduction to Modern Physics	
300-level or higher lecture- or laboratory-based course <sup>a</sup>		
Engineering Elective <sup>b</sup>		3
<b>Total Credit Hours</b>		<b>56-57</b>

a Excludes research and independent study courses. Must be taken in an engineering or designated science department (Chemistry, Physics, Biology or Biochemistry).

b Any lecture- or laboratory-based course (research and independent study courses are excluded) that is 200-level or higher, offered by the engineering school exclusive of the Department of Computer and Data Science

**Technical Breadth Elective Sequences**

A distinctive feature of the chemical engineering program is the three-course, 9-11 credit hours, breadth elective sequence that enables a student to specialize in a technical or professional area that complements the chemical engineering core. Breadth elective sequences that have standing departmental approval are described below. Alternatively, students may design their own breadth elective sequence, which must be approved by the department.

**Biomolecular Engineering**

Code	Title	Credit Hours
<b>Required Courses:</b>		
BIOL 301	Biotechnology Laboratory: Genes and Genetic Engineering	3
BIOL 343	Microbiology	3
ECHE 340	Biochemical Engineering	3
<b>Total Credit Hours</b>		<b>9</b>

**Computing**

Code	Title	Credit Hours
<b>Required Courses:</b>		
ECSE 281	Logic Design and Computer Organization	4

ECSE 346	Engineering Optimization	3
ECSE course <sup>a</sup>		3-4
<b>Total Credit Hours</b>		<b>10-11</b>

a Must be 200 level or above.

**Design and Manufacturing**

Code	Title	Credit Hours
<b>Required Courses:</b>		
EMAE 160	Mechanical Manufacturing	3
EMAE 260	Design and Manufacturing I	3
EMAE 360	Design and Manufacturing II	3
<b>Total Credit Hours</b>		<b>9</b>

**Electrochemical Engineering**

Code	Title	Credit Hours
<b>Required Courses:</b>		
ECHE 381	Electrochemical Engineering	3
ECHE 383	Chemical Engineering Applied to Microfabrication and Devices	3
<i>Choose one of the following:</i>		3-4
EMSE 343	Processing of Electronic Materials	
ECSE 309	Electromagnetic Fields I	
ECSE 321	Semiconductor Electronic Devices	
ECHE 481	Corrosion Fundamentals	
<b>Total Credit Hours</b>		<b>9-10</b>

**Electronic Materials**

Code	Title	Credit Hours
<b>Required Courses:</b>		
ECHE 383	Chemical Engineering Applied to Microfabrication and Devices	3
ECSE 309	Electromagnetic Fields I	3
<i>Choose one of the following:</i>		3-4
ECSE 321	Semiconductor Electronic Devices	
EMSE 343	Processing of Electronic Materials	
<b>Total Credit Hours</b>		<b>9-10</b>

**Energy**

Code	Title	Credit Hours
<b>Required Courses:</b>		
ECHE 381	Electrochemical Engineering	3
Electives <sup>a</sup>		6-7
<b>Total Credit Hours</b>		<b>9-10</b>

a Two additional courses selected from approved energy courses in Engineering, Physics, Chemistry, Management, or Law.

## Environmental Engineering

Code	Title	Credit Hours
<b>Required Courses:</b>		
ECIV 368	Environmental Engineering	3
<i>Choose two of the following:</i>		6
ECIV 351	Engineering Hydraulics and Hydrology	
ECIV 361	Water Resources Engineering	
ECIV 362	Solid and Hazardous Waste Management	
ECSE 342	Introduction to Global Issues	
EEPS 220	Environmental Geology	
EEPS 303	Environmental Law	
EEPS 321	Hydrogeology	
ESTD 398	Seminar in Environmental Studies	
<b>Total Credit Hours</b>		<b>9</b>

## Management/Entrepreneurship

Code	Title	Credit Hours
<b>Required Courses:</b>		
ACCT 100	Foundations of Accounting I	3
<i>Choose two of the following:</i>		6
BAFI 355	Corporate Finance	
or BAFI 341	Money and Banking	
BLAW 331	Legal Environment of Management	
ENTP 301	Entrepreneurial Strategy	
or ENTP 311	New Venture Creation	
MGMT 315	International Management Institute	
OPRE 301	Operations Research and Supply Chain Management	
<b>Total Credit Hours</b>		<b>9</b>

## Polymer Science

Code	Title	Credit Hours
<b>Required Courses:</b>		
EMAC 270	Introduction to Polymer Science and Engineering	3
<i>Choose two of the following:</i>		6
EMAC 276	Polymer Properties and Design	
EMAC 376	Polymer Engineering	
EMAC 377	Polymer Processing	
EMAC 378	Polymer Engineer Design Product	
EMAC 303	Structure of Biological Materials	
<b>Total Credit Hours</b>		<b>9</b>

## Pre-Medical

Code	Title	Credit Hours
<b>Required Courses:</b>		
CHEM 113	Principles of Chemistry Laboratory	2
BIOL 214	Genes, Evolution and Ecology	3
BIOL 214L	Genes, Evolution and Ecology Lab	1
BIOL 215	Cells and Proteins	3

BIOL 215L	Cells and Proteins Laboratory	1
<b>Total Credit Hours</b>		<b>10</b>

## Research

Code	Title	Credit Hours
<b>Required Courses:</b>		
ECHE 350	Undergraduate Research Project I	3
ECHE 351	Undergraduate Research Project II	3
Elective <sup>a</sup>		3
<b>Total Credit Hours</b>		<b>9</b>

a Must be approved by sequence advisor.

## Systems and Control

Code	Title	Credit Hours
<b>Required Courses:</b>		
ECSE 281	Logic Design and Computer Organization	4
ECSE 304	Control Engineering I with Laboratory	3
ECSE 346	Engineering Optimization	3
<b>Total Credit Hours</b>		<b>10</b>

## BS/MS Advanced Study Sequence

Code	Title	Credit Hours
<b>Required Courses:</b>		
Three 400-level 3 credit hour ECHE courses		9
<b>Total Credit Hours</b>		<b>9</b>

## Custom-Designed Sequence

Code	Title	Credit Hours
Students can design a custom breadth elective sequence, consisting of three courses (9 credits) that fit in one coherent technical or professional theme. The courses must be technical or professional courses (see footnote a) that are 200-level or higher, with at least one of the courses being 300-level or higher. These courses cannot be research or independent study courses. Students interested in this option should submit a petition to their advisor naming and explaining the coherent theme, why this theme complements the chemical engineering core for him/her, and how the three courses fit into this theme. The petition must be approved by the Undergraduate Studies Committee of the Department of Chemical and Biomolecular Engineering. <sup>a</sup>		9

Students can design a custom breadth elective sequence, consisting of three courses (9 credits) that fit in one coherent technical or professional theme. The courses must be technical or professional courses (see footnote a) that are 200-level or higher, with at least one of the courses being 300-level or higher. These courses cannot be research or independent study courses. Students interested in this option should submit a petition to their advisor naming and explaining the coherent theme, why this theme complements the chemical engineering core for him/her, and how the three courses fit into this theme. The petition must be approved by the Undergraduate Studies Committee of the Department of Chemical and Biomolecular Engineering.<sup>a</sup>

a For the purpose of the sequences, "technical and professional courses" are defined as courses that would not satisfy the humanities and social sciences requirement of the Case School of Engineering; also excluded are courses in Asian Studies (ASIA), Childhood Studies (CHST), Ethnic Studies (ETHS), Jewish Studies (JWST), Applied Music (MUAP), Education (EDUC), Women, Gender and Sexuality Studies (WGST), Washington Semester (WASH), and other courses deemed by the department to be of this genre.

## Pre-Medical Option

By using the flexibility provided by science and technical electives in the curriculum, students are able to pursue courses that provide the background needed for medical school. Students choose the following electives to meet the course requirements of most medical schools.

Code	Title	Credit Hours
Science/Engineering elective: CHEM 224 or CHEM 324		3
Chemistry labs: CHEM 233 and CHEM 234 instead of CHEM 290		6
Breadth Elective Sequence: Pre-Medical sequence (described above)		10
One extra course: BIOC 307		4

## Sample Plan of Study

The following is a suggested program of study. Current students should always consult their advisers and their individual graduation requirement plans as tracked in SIS.

### First Year

Fall		Credit Hours
CHEM 111	Principles of Chemistry for Engineers	4
MATH 121	Calculus for Science and Engineering I	4
ENGR 130	Foundations of Engineering and Programming	3
ECHE 151	Introduction to Chemical Engineering at Case	1
Academic Inquiry Seminar, Breadth, or Elective course <sup>a</sup>		3
<b>Credit Hours</b>		<b>15</b>

### Spring

ENGR 145	Chemistry of Materials	4
MATH 122 or MATH 124	Calculus for Science and Engineering II <sup>b</sup> or Calculus II	4
PHYS 121	General Physics I - Mechanics	4
Academic Inquiry Seminar, Breadth, or Elective course <sup>a</sup>		3
<b>Credit Hours</b>		<b>15</b>

### Second Year

Fall		Credit Hours
CHEM 223 or CHEM 323	Introductory Organic Chemistry I <sup>b</sup> or Organic Chemistry I	3
MATH 223 or MATH 227	Calculus for Science and Engineering III <sup>b</sup> or Calculus III	3
ECHE 260	Introduction to Chemical Systems	3
ECHE 225	Thermal and Fluid Sciences	4
Breadth, or Elective course <sup>a</sup>		3
<b>Credit Hours</b>		<b>16</b>

### Spring

MATH 224 or MATH 228	Elementary Differential Equations <sup>b</sup> or Differential Equations	3
ECHE 313 or STAT 312 or STAT 313	Statistical Analysis of Chemical Processes or Basic Statistics for Engineering and Science or Statistics for Experimenters	3
ECHE 363	Thermodynamics of Chemical Systems	4

PHYS 122	General Physics II - Electricity and Magnetism	4
Breadth, or Elective course <sup>a</sup>		3
<b>Credit Hours</b>		<b>17</b>

### Third Year

Fall		Credit Hours
ECHE 360	Transport Phenomena for Chemical Systems	4
ECHE 367	Process Control	4
ENGR 210	Introduction to Circuits and Instrumentation	4
CHEM 290	Chemical Laboratory Methods for Engineers	3
<b>Credit Hours</b>		<b>15</b>

### Spring

ECHE 361	Separation Processes	4
ECHE 364	Chemical Reaction Processes	4
ECHE 365	Measurements Laboratory	3
ENGR 399	Impact of Engineering on Society	3
Breadth, or Elective course <sup>a</sup>		3
<b>Credit Hours</b>		<b>17</b>

### Fourth Year

Fall		Credit Hours
ECHE 362	Chemical Engineering Laboratory	4
ECHE 398	Process Analysis, Design and Safety	4
Technical Breadth Elective <sup>c</sup>		3
Technical Breadth Elective <sup>c</sup>		3
Breadth, or Elective course <sup>a</sup>		3
<b>Credit Hours</b>		<b>17</b>

### Spring

ECHE 399	Chemical Engineering Design Project	3
Engineering elective <sup>d</sup>		3
Science/Engineering Elective <sup>d</sup>		3
Technical Breadth Elective <sup>c</sup>		3
Breadth, or Elective course <sup>a</sup>		3
<b>Credit Hours</b>		<b>15</b>
<b>Total Credit Hours</b>		<b>127</b>

a Unified General Education Requirement.

b Advanced courses are available to students by invitation only.

c A three-course (9-11 credit hours) breadth sequence, as described above.

d The course cannot double count towards any other requirement of the major.