Chemical Engineering, B.S.E.

Educational Objectives

The chemical engineering program produces graduates with a strong foundation of scientific and technical knowledge who are equipped with problem-solving, teamwork, and communication skills that will serve them throughout their careers consistent with the following educational objectives. Within a few years following graduation, graduates will:

- attain careers as practicing chemical engineers in fields such as biotechnology, chemicals, computation, energy, environmental engineering, food processing, microelectronics, pharmaceuticals, or polymers/advanced materials;
- pursue advanced studies in disciplines such as business, chemical engineering, dentistry, environmental engineering, law, medicine, or pharmaceuticals; or
- assume professional leadership roles.

The following methods and strategies are used in the chemical engineering undergraduate program to achieve these program educational objectives:

- foster a unique and personalized undergraduate experience by leveraging the advantages of a small college atmosphere within a comprehensive liberal arts and research university;
- provide a diverse, inclusive, and equitable environment for all students;
- enrich the undergraduate experience through cultural diversity, international opportunities, and/or experiential learning;
- provide a solid foundation and understanding of the fundamental principles of mathematics, science, and engineering;
- provide students with experience in learning and applying tools, and analyzing and interpreting data, to solve theoretical and open-ended chemical engineering problems;
- provide students with opportunities to participate in collaborative teams;
- develop students' written and oral communication skills to a wide range of audiences;
- provide students with opportunities to design and conduct chemical engineering experiments and to design systems, components, and chemical processes to meet specific needs and constraints;
- provide a contemporary grounding in ethical and professional responsibility, including global, economic, environmental, safety, and societal impacts of engineering decisions; and
- instill the desire and the understanding of the need for lifelong learning.

Requirements

The Bachelor of Science in Engineering requires a minimum of 128 s.h. of credit. Students must have a g.p.a. of at least 2.00 on all college work used to satisfy degree requirements as well as on all work undertaken at the University of Iowa.

Seminars do not count toward the 128 s.h. required for the degree.

The major in chemical engineering provides a broad education at the leading edge of technology. It emphasizes fundamental concepts, problem solving, laboratory techniques, and communication skills. The biological sciences join physics, chemistry, and mathematics as foundation disciplines for chemical engineering.

All engineering students complete the B.S.E. core requirements, which include RHET:1030 Rhetoric; ENGR:1100 Introduction to Engineering Problem Solving and ENGR:1300 Introduction to Engineering Computing; and courses in chemistry, physics, engineering mathematics and fundamentals, and the general education component. For information about the B.S.E. requirements, see Bachelor of Science in Engineering, B.S.E. in the Catalog.

The sophomore, junior, and senior years emphasize chemical engineering courses such as process calculations, fluid flow, chemical engineering thermodynamics, heat and mass transfer, separations, chemical reaction engineering, chemical process safety, chemical engineering laboratories, biochemical engineering, process dynamics and control, and process design. Experience in instrumentation, analysis, and design is obtained through an integrated laboratory program. Routine use is made of computer-based data analysis, simulation, and design.

Students are required to participate in at least one enriching activity, which may include a research experience, a cooperative education or internship experience, study abroad, completion of the Certificate in Technological Entrepreneurship, or other approved experiences.

Chemical engineering students may gain depth of knowledge related to a career path through their selection of science, engineering, and general education electives. Several preapproved focus areas may help students define potential careers.

Students must select focus area courses according to guidelines established by the Department of Chemical and Biochemical Engineering. See “Focus Area” below.

Focus Area

The focus area enables students to gain depth of knowledge in a career path. Students meet with their chemical engineering academic advisor to discuss career options and develop a plan for choosing electives based on their career interests. The department offers preapproved focus areas in biochemical engineering; business; chemical process engineering; computation, data science, and machine learning; energy and environment; entrepreneurship; oil and gas engineering; pharmaceuticals; polymers; pre-medicine; and sustainability.

Students may prefer to develop an individualized focus area, which is subject to approval by the department's curriculum committee. See Chemical Engineering Curriculum on the Department of Chemical and Biochemical Engineering website for detailed descriptions of preapproved focus areas, guidelines for tailored focus areas, and typical four-year study plans based on focus areas.

Biochemical Engineering

This focus area allows students to choose from a selection of courses that combines concepts of biology, biochemistry, and engineering. Biochemical engineers combine knowledge of these three areas to manufacture products of biological
nature, including fermentation products and pharmaceuticals. Students often go on to work in the biotechnology and pharmaceutical industries as production leaders or researchers.

Business
This focus area consists of eight core courses from the Tippie College of Business. Students gain foundational business knowledge on topics including finance, economics, accounting, marketing, law, and management. Past students have applied their integrated business and technical knowledge to many different settings ranging from manufacturing plants to consulting and to corporate offices.

Chemical Process Engineering
Process engineering is the design, optimization, and operation of systems that transform raw materials into valuable products. Process engineers are involved with products, including foods and beverages, electronic materials, metals, plastics, fuels, building materials, and pharmaceutics. Since chemical process engineering spans many aspects of engineering, business, applied math, and science, students can choose 12 s.h. of electives from a broad selection of 3000-level engineering, math, and science courses. This focus area provides ample room for customization and opportunities to tailor to individualized interests.

Students who do not declare a specific focus area are automatically placed in chemical process engineering.

Computation, Data Science, and Machine Learning
This focus area is for students who intend to blend advanced computation and programming with their chemical engineering degree. This area is customizable based on student interest areas, and can accommodate introductory training in cyber-physical systems, remote sensing, advanced simulation, supply chain management, in silico chemistry and biology, bioinformatics, software design, next-generation training in cyber-physical systems, remote sensing, advanced computation and programming with their chemical engineering degree. This area is customizable based on student interest areas, and can accommodate introductory training in cyber-physical systems, remote sensing, advanced simulation, supply chain management, in silico chemistry and biology, bioinformatics, software design, next-generation engineering, including foods and beverages, electronic materials, metals, plastics, fuels, building materials, and pharmaceutics. Since chemical process engineering spans many aspects of engineering, business, applied math, and science, students can choose 12 s.h. of electives from a broad selection of 3000-level engineering, math, and science courses. This focus area provides ample room for customization and opportunities to tailor to individualized interests.

Energy and Environment
Students who are passionate about the environment should consider this focus area. Courses prepare students to solve environmental challenges and to revolutionize energy systems. Topics include air pollution, climate change, clean and renewable energy, environmental regulations, and sustainable systems.

Entrepreneurship
This focus area allows students to focus on the process of succeeding in the world of startups, innovation, business ownership, and new products. The area is well suited for students who intend to start and operate their own business. It also serves students interested in gaining a better understanding of managing innovation in an existing business environment. The wide range of electives permits students to tailor business courses best suited to their individual interests.

Oil and Gas Engineering
Meant for students interested in pursuing careers in oil and gas engineering, this focus area explores foundational elements of chemistry, geology, petrochemical refining, and environmental science. The course plan offers several recommendations put in place by experienced advisors with petrochemical backgrounds. Often viewed as the birth of chemical engineering, the petroleum industry provides a host of challenging and lucrative opportunities for chemical engineers. This path provides a unique and focused introduction to the field.

Pharmaceuticals
Chemical and biochemical engineering is central to the design, formulation, and manufacturing of pharmaceutical products. Students who are passionate about medical applications can align their chemical engineering skills toward a career in pharmaceuticals by choosing this focus area. The curriculum features biology, drug delivery, and the mechanisms and chemistry of drug interactions. Course options span many departments besides chemical and biochemical engineering, including biomedical engineering, biochemistry and molecular biology, pharmacy, and pharmacology.

Polymers
This focus area enables students to study the development of chemical compounds by polymerization, including combining small molecules into engineered networks to produce valuable plastics and other advanced materials. The program is well suited for students who intend to use their knowledge to design new materials; it also serves students interested in gaining a better understanding of the links between molecular scale structure and macroscopic scale properties.

Pre-Medicine
Concepts of chemical engineering are naturally applicable to the processes in living organisms. This focus area enables students to apply these concepts to gain a deeper understanding of the atoms and molecules that comprise living organisms, and the pathways through which they operate. This program is for students who intend to use their knowledge to gain acceptance to post-graduate education in the medical field.

Safety and Health
This focus area prepares students to (1) prevent incidents and accidents in chemical and pharmaceutical manufacturing, particularly those resulting from the unintentional release of hazardous materials and energy into the environment; and (2) provide a safe and healthy workplace by preventing injuries and hazards in the workplace environment.

Sustainability
This focus area covers the most important and current topics in environmental science, societal impacts, energy usage, and natural systems. Courses prepare students to understand and discuss these topics as they relate to chemical engineering.

Combined Programs
B.S.E./M.S. in Chemical and Biochemical Engineering
The College of Engineering offers a combined Bachelor of Science in Engineering/Master of Science for chemical engineering undergraduate students who intend to earn a M.S. in chemical and biochemical engineering. B.S.E./M.S. students may count 12 s.h. of coursework (typically advanced chemistry sequences and electives) toward both degrees. Once students complete the requirements for the bachelor's
degree, they are granted the B.S.E., and they typically complete the M.S. one year later.

To be admitted to the degree program, students must have a cumulative g.p.a. of at least 3.25, and submit a letter of application and statement of purpose to the chair of the Department of Chemical and Biochemical Engineering. Visit U2G Programs on the department’s website to learn more.

**B.S.E./M.S. in Civil and Environmental Engineering**

Bachelor of Science in Engineering students majoring in chemical engineering who are interested in earning a Master of Science in civil and environmental engineering may apply to the combined B.S.E./M.S. program offered by the College of Engineering. The combined program enables undergraduate students to begin work on the M.S. degree while completing their B.S.E. degree. Students admitted to the program may count 9 s.h. of coursework toward both the B.S.E. and the M.S. degree requirements. They also may count an additional 3 s.h. toward the M.S. degree requirements before they have been awarded the B.S.E. degree. For more information, see the M.S. in civil and environmental engineering in the Catalog.

**Chemical Engineering, B.S.E.**

<table>
<thead>
<tr>
<th>Course First Year</th>
<th>Title</th>
<th>Hours</th>
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<tbody>
<tr>
<td><strong>Fall</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RHET:1030</td>
<td>Rhetoric</td>
<td>4</td>
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<tr>
<td>MATH:1550</td>
<td>Engineering Mathematics I: Single Variable Calculus</td>
<td>4</td>
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<tr>
<td>CHEM:1110</td>
<td>Principles of Chemistry I</td>
<td>4</td>
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<tr>
<td>ENGR:1100</td>
<td>Introduction to Engineering Problem Solving</td>
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<tr>
<td>ENGR:1000</td>
<td>Engineering Success for First-Year Students</td>
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<tr>
<td>CSI:1600</td>
<td>Success at Iowa</td>
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<tr>
<td><strong>Hours</strong></td>
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<td><strong>16</strong></td>
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<tr>
<td><strong>Spring</strong></td>
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<tr>
<td>MATH:1560</td>
<td>Engineering Mathematics II: Multivariable Calculus</td>
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<tr>
<td>MATH:2550</td>
<td>Engineering Mathematics III: Matrix Algebra</td>
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<tr>
<td>CHEM:1120</td>
<td>Principles of Chemistry II</td>
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<tr>
<td>PHYS:1611</td>
<td>Introductory Physics I</td>
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<tr>
<td>ENGR:1300</td>
<td>Introduction to Engineering Computing</td>
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<td>CBE:1000</td>
<td>CBE Departmental Seminar</td>
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<td><strong>Hours</strong></td>
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<td><strong>Second Year</strong></td>
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<tr>
<td>GE: Engineering Be Creative</td>
<td></td>
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<tr>
<td>MATH:2560</td>
<td>Engineering Mathematics IV: Differential Equations</td>
<td>3</td>
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<tr>
<td>CHEM:2230 or CHEM:2210</td>
<td>Organic Chemistry I for Majors or Organic Chemistry I</td>
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<tr>
<td>ENGR:2130</td>
<td>Thermodynamics</td>
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<td>CBE:2110</td>
<td>Computational Tools for Chemical Engineers</td>
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<td>CBE:2105</td>
<td>Process Calculations</td>
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<td><strong>Hours</strong></td>
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<td><strong>17</strong></td>
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<tr>
<td><strong>Spring</strong></td>
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<tr>
<td>GE: Diversity and Inclusion</td>
<td></td>
<td>3</td>
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<tr>
<td>CHEM:2220 or CHEM:2240</td>
<td>Organic Chemistry II or Organic Chemistry II for Majors</td>
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<tr>
<td>CHEM:2420 or CHEM:2410</td>
<td>Organic Chemistry Laboratory for Majors or Organic Chemistry Laboratory</td>
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<td>CBE:3105</td>
<td>Chemical Engineering Thermodynamics</td>
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<td>CBE:3109</td>
<td>Fluid Flow</td>
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<td>CBE:3000</td>
<td>Professional Seminar: Chemical Engineering</td>
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<td><strong>Hours</strong></td>
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<td><strong>Third Year</strong></td>
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<tr>
<td>ENGR:2720</td>
<td>Materials Science</td>
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<tr>
<td>CBE:3113</td>
<td>Heat and Mass Transfer</td>
<td>3</td>
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**Career Advancement**

Chemical and biochemical engineers work in a wide range of industries, including petroleum and specialty chemical production, polymer and plastic production, food processing, energy, microelectronics production, pharmaceutical production, biochemical processing, and environmental compliance. Potential jobs include production, process development, plant design and construction, and fundamental research. Many experienced chemical and biochemical engineers move through management ranks to high-level administrative positions. On average, 93-98 percent of graduates are employed in their field of study or pursuing advanced education within seven months of graduation.

The engineering profession is a foundation for a variety of careers in industry, medicine, law, government, and consulting. Engineering majors hold eight of the top ten spots on the list of top-paid majors for bachelor's degree graduates, according to the National Association of Colleges and Employers (NACE).

Engineering Career Services develops and promotes experiential education and professional opportunities for students in the College of Engineering. Professional staff coordinate the college’s co-op and internship program, engage in employer outreach, and provide opportunities for students to network with employers, including an engineering career fair each semester and other programming related to career development.

Engineering Career Services also offers individual advising and class presentations on résumé and cover letter preparation, job and internship search strategies, interviewing skills, and job offer evaluation.

**Academic Plans**

**Sample Plan of Study**

Sample plans represent one way to complete a program of study. Actual course selection and sequence will vary and should be discussed with an academic advisor. For additional sample plans, see MyUI.
CBE:3125  Chemical Process Safety  3
CBE:3117  Separations  3
CBE:3000  Professional Seminar: Chemical Engineering  1
Elective course  3

**Hours**  16

### Spring

**GE: Approved Course Subjects**  3
CBE:3120  Chemical Reaction Engineering  3
CBE:3150  Thermodynamics/Transport Laboratory  3
CBE:3205  Introduction to Biochemical Engineering  3
Elective: focus area course  3
CBE:3000  Professional Seminar: Chemical Engineering  1

**Hours**  16

### Fourth Year

#### Fall

CBE:3155  Chemical Reaction Engineering/ Separations Laboratory  3
CBE:3000  Professional Seminar: Chemical Engineering  1
CBE:4105  Process Dynamics and Control in Design  3
CBE:4109  Chemical Engineering Process Design I  3
Elective: advanced chemistry course  3
Elective: focus area course  3
Elective: focus area course  3

**Hours**  18

#### Spring

**GE: Approved Course Subjects**  3
CBE:4110  Chemical Engineering Process Design II  3
Elective: advanced science course  3
Elective: focus area course  3
CBE:4195  Senior Enriching Activities Seminar  0

**Degree Application: apply on MyUI before deadline (typically in February for spring, September for fall)**

**Hours**  15

**Total Hours**  134

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**Notes:**

a. Typically this course is offered in fall, spring, and summer sessions. Check MyUI for course availability since offerings are subject to change.

b. Typically this course is offered in fall and spring semesters. Check MyUI for course availability since offerings are subject to change.

c. Enrollment in math courses requires completion of a placement exam.

d. Enrollment in chemistry courses requires completion of a placement exam.

e. Typically this course is offered in fall semesters only. Check MyUI for course availability since offerings are subject to change.

f. Typically this course is offered in spring semesters only. Check MyUI for course availability since offerings are subject to change.

h. CHEM:2210 typically is offered in fall, spring, and summer sessions. CHEM:2230 typically is offered in fall semesters only. Check MyUI for course availability since offerings are subject to change.

i. Students select a course from the GE CLAS Core Diversity and Inclusion area.

j. CBE:3020 typically is offered in spring semesters only. STAT:2020 typically is offered in fall, spring, and summer sessions. STAT:3510 typically is offered in fall and spring sessions. Check MyUI for course availability since offerings are subject to change.

k. CHEM:2220 typically is offered in fall, spring, and summer sessions. CHEM:2240 typically is offered in spring semesters only. Check MyUI for course availability since offerings are subject to change.

l. CHEM:2410 typically is offered in fall, spring, and summer sessions. CHEM:2420 typically is offered in spring semesters only. Check MyUI for course availability since offerings are subject to change.

m. Students may use elective courses to earn credit towards the total s.h. required for graduation or to complete a double major, minors, or certificates.

n. A full list of approved course subjects can be found on the College of Engineering General Education Component website. Some focus areas may suggest or require specific courses to fulfill the General Education Component. See the chemical and biochemical engineering website or consult an advisor for more information.

o. Students choose one of many preexisting focus areas or work with an advisor to develop a custom focus area. Some focus areas may suggest or require specific courses to fulfill the General Education Component. See the chemical and biochemical engineering website or consult an advisor for more information.

p. The advanced chemistry course must have a course subject of CHEM or BIOC. Some focus areas may suggest or require specific courses to fulfill the advanced chemistry requirement. See the chemical and biochemical engineering website or consult an advisor for more information.

q. The advanced science course may be fulfilled with science-based courses offered in the College of Engineering or in science departments outside of the College of Engineering. Some focus areas may suggest or require specific courses to fulfill the advanced science requirement. See the chemical and biochemical engineering website or consult an advisor for more information.

r. Please see Academic Calendar, Office of the Registrar website for current degree application deadlines. Students should apply for a degree for the session in which all requirements will be met. For any questions on appropriate timing, contact your academic advisor or Graduation Services.