

# CHEMICAL ENGINEERING

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Energy, the environment, and health care are key challenges facing humanity in the twenty-first century. Chemical engineering is a discipline well placed to confront these challenges. Chemical engineering is rooted in the basic sciences of mathematics, chemistry, physics, and biology; a traditional engineering science core of thermodynamics, transport phenomena, and chemical kinetics; a rigorous design component; and an expanding focus on emerging topics in materials, nanotechnology, and life sciences. The discipline has grown from its petrochemical origins to become central to state-of-the-art technologies in microelectronics, alternative energy, biomedicine, and pharmaceuticals.

The Chemical Engineering program, with two degree programs (see below), is principally focused on basic and engineering sciences and on problem solving. Additional emphasis is on communication, analysis of experiments, and chemical process design. A special feature of the program is the accessibility of laboratory research – most chemical engineering majors participate in faculty-led research projects, often resulting in publication and/or presentation at national meetings.

Chemical engineering graduates find a wide range of professional opportunities in academia, industry, government, business, and the nonprofit sector. Many majors go on to graduate programs in chemical, biomedical, or environmental engineering, or to medical, law, or business schools.

Upon graduation, Yale's Chemical Engineering students are expected to have achieved "Student Outcomes" as defined by ABET ([www.abet.org](http://www.abet.org)) and the program. The Chemical Engineering major produces graduates who demonstrate: (1) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics; (2) 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; (3) an ability to communicate effectively with a range of audiences; (4) an ability to recognize ethical and professional responsibilities in engineering situations and to make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts; (5) 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; (6) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions; and (7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Yale and ABET also look ahead, several years beyond graduation. Program educational objectives provide the expectations for graduates early in their career. The Chemical Engineering objectives are to produce graduates who: (1) have mastery of the basic principles of science and modern chemical engineering practice and are able to adapt and creatively apply them to solve new problems in a broad range of fields; (2) become

ethical professionals who advance chemical engineering practice and knowledge in multiple fields and recognize the local and global impacts of their work on humans and the environment; (3) are able to work well with people from diverse backgrounds and are committed to the advancement of women and under-represented groups in engineering; (4) have a strong educational foundation enabling them to study in graduate and professional schools as well as become leaders in STEM or non-STEM career paths; and (5) are committed to, and engage in, lifelong learning throughout their careers.

### PREREQUISITES

Students considering a Chemical Engineering major are encouraged to take two terms of chemistry and mathematics during the first year, and to contact the director of undergraduate studies (DUS).

Students in both degree programs (see below) take the following prerequisite courses: MATH 112, 115, and ENAS 151 or MATH 120; CHEM 161 and 165 or CHEM 163 and 167; CHEM 134L and 136L; PHYS 180, 181 or PHYS 200, 201 or PHYS 260. Students with advanced high school preparation may reduce the number of prerequisites by placing out of certain courses.

### REQUIREMENTS OF THE MAJOR

**Students are held to the requirements that were in place when they declared their major.** However, with approval from the director of undergraduate studies (DUS), the following requirements may be fulfilled by students who declared the major in a prior term.

Two degree programs are offered: a B.S. in Chemical Engineering accredited by the Engineering Accreditation Commission of ABET, Inc., and a B.S. in Engineering Sciences (Chemical). All students majoring in Chemical Engineering and Engineering Sciences (Chemical) must follow the requirements listed below as approved by the program's faculty.

**B.S. degree program in Chemical Engineering** The curriculum for the ABET-accredited B.S. degree in Chemical Engineering requires 19 courses, totaling 18.5 credits, including the senior requirement (CENG 416), and the following courses beyond the prerequisites:

1. Computing: ENAS 130 or CPSC 100 or CPSC 112 or CPSC 200
2. Mathematics: ENAS 194
3. Chemistry: CHEM 174 or CHEM 220; CHEM 222L; CHEM 332 and 333
4. Engineering science: Four term courses chosen from engineering electives
5. Chemical engineering: CENG 150 or CENG 210; CENG 300, 301, 314 (or MENG 361), CENG 315, 411, 412L, 480

**B.S. degree program in Engineering Sciences (Chemical)** The B.S. degree in Engineering Sciences (Chemical) requires 12 term courses for 12 credits, including the senior requirement, CENG 416 or CENG 490, and the following courses beyond the prerequisites, chosen in consultation with the DUS:

1. Computing: ENAS 130 or CPSC 100 or CPSC 112 or CPSC 200
2. Mathematics: ENAS 194
3. Chemistry: CHEM 174 or CHEM 220; and CHEM 332
4. Engineering science (chemical): One term course chosen from engineering electives
5. Chemical engineering: CENG 150 or CENG 210; CENG 300, 301, 314 (or MENG 361), CENG 315, 411

#### SENIOR REQUIREMENT

**B.S. degree program in Chemical Engineering** In their senior year, students must complete a senior research project in CENG 416.

**B.S. degree program in Engineering Sciences (Chemical)** In their senior year, students must complete a senior research project in CENG 416 or CENG 490.

### SUMMARY OF MAJOR REQUIREMENTS

#### CHEMICAL ENGINEERING, B.S.

**Prerequisites** MATH 112, 115; ENAS 151 or MATH 120; CHEM 161 and 165 or CHEM 163 and 167; CHEM 134L and 136L; PHYS 180, 181 or PHYS 200, 201 or PHYS 260.

**Number of courses** 19 courses, totaling 18.5 credits, beyond prereqs (incl senior req)

**Specific courses required** ENAS 194; CHEM 174 or CHEM 220; CHEM 222L; CHEM 332, 333; CENG 150 or CENG 210; CENG 300, 301, 314 (or MENG 361), CENG 315, 411, 412L, 480

**Distribution of courses** 1 from ENAS 130, CPSC 100, 112, or 200; 4 addtl electives in engineering

**Senior requirement** CENG 416

#### ENGINEERING SCIENCES (CHEMICAL), B.S.

**Prerequisites** MATH 112, 115; ENAS 151 or MATH 120; CHEM 161 and 165 or CHEM 163 and 167; CHEM 134L and 136L; PHYS 180, 181 or PHYS 200, 201 or PHYS 260.

**Number of courses** 12 term courses for 12 credits beyond prereqs (incl senior req), chosen in consultation with DUS

**Specific courses required** ENAS 194; CENG 150 or CENG 210; CENG 300, 301, 314 (or MENG 361), CENG 315, 411

**Distribution of courses** 1 from ENAS 130, CPSC 100, 112, or 200; CHEM 174 or CHEM 220; CHEM 332; 1 engineering elective

**Senior requirement** CENG 416 or CENG 490

#### Prerequisites

- MATH 112
- MATH 115

- ENAS 151 or MATH 120
- CHEM 161 and CHEM 165 or CHEM 163 and CHEM 167
- CHEM 134L and 136L
- PHYS 180 and 181 or PHYS 200 and PHYS 201 or PHYS 260

### **Requirements**

#### **B.S. Chemical Engineering (ABET accredited)**

19 courses (18.5 credits) beyond the prerequisites, including the senior requirement

- One of the following ENAS 130, CPSC 100, CPSC 112, or CPSC 200
- ENAS 194
- CHEM 174 or CHEM 220
- CHEM 222L (half credit)
- CHEM 332 and 333
- CENG 150 or 210
- CENG 300
- CENG 301
- CENG 314 or MENG 361
- CENG 315
- CENG 411
- CENG 412L
- CENG 480
- 4 engineering electives
- CENG 416 (senior requirement)

#### **B. S. Engineering Sciences (Chemical)**

12 courses (12 credits) beyond the prerequisites, including the senior requirement

- One of the following ENAS 130, CPSC 100, CPSC 112, or CPSC 200
- ENAS 194
- CHEM 174 or CHEM 220
- CHEM 332
- CENG 150 or CENG 210
- CENG 300

- CENG 301
- CENG 314 or MENG 361
- CENG 315
- CENG 411
- 1 engineering elective
- CENG 416 or CENG 490 (senior requirement)

The program in Chemical Engineering principally focuses on basic and engineering sciences and on problem solving. It also emphasizes communication, analysis of experiments, and chemical process design. A special feature of the program is the accessibility of laboratory research. Most chemical engineering majors participate in faculty-led research projects that can lead to publication and/or presentation at national meetings.

The program's educational objectives include providing graduates with an excellent engineering science background for graduate study in chemical, biomedical, or environmental engineering programs, or in medicine or law; preparing graduates for a diverse range of industrial careers; and providing graduates with a broad liberal arts education.

Two degree options are offered: a B.S. degree in Chemical Engineering that is accredited by the Engineering Accreditation Commission of ABET, Inc., and an unaccredited B.S. degree in Engineering Sciences (Chemical). The prerequisites for both degree programs are three terms of calculus, two terms of general chemistry with laboratory, and two terms of physics. Students with advanced high school preparation may move ahead to more advanced courses.

There is considerable flexibility for tailoring the program to match individual interests. Students are encouraged to contact the director of undergraduate studies ([paul.vantassel@yale.edu](mailto:paul.vantassel@yale.edu)) (DUS) ([michael.loewenberg@yale.edu](mailto:michael.loewenberg@yale.edu)) directly.

#### FACULTY OF THE DEPARTMENT OF CHEMICAL AND ENVIRONMENTAL ENGINEERING

**Professors** Eric Altman, †Paul Anastas, †Michelle Bell, †Ruth Blake, Menachem Elimelech, John Fortner, Gary Haller (*Emeritus*), †Edward Kaplan, Jaehong Kim, Michael Loewenberg, †Andrew Miranker, Jordan Peccia, Lisa Pfefferle, Daniel Rosner (*Emeritus*), †Mark Saltzman, †Udo Schwarz, T. Kyle Vanderlick, Paul Van Tassel, Julie Zimmerman

**Associate Professors** Drew Gentner, Mingjiang Zhong

**Assistant Professors** Peijun Guo, Amir Haji-Akbari, †Shu Hu, Lea Winter

**Lecturers** †Anikó Bezur, †Paul Whitmore

†A joint appointment with primary affiliation in another department or school.

View Courses