Chemical Engineeering, B.S.

Chemical engineers exploit advances in chemistry and biology to create new products, design chemical processes, develop energy resources, and protect the environment. Students receive a thorough grounding in chemistry, biology, mathematics, and physics. With this broad scientific training, chemical engineers work effectively on a diverse set of problems involving chemical, physical, and biological phenomena. For example, chemical engineers develop environmentally benign and safe processes to make the chemical products that people depend on. They work in research and development laboratories, creating polymeric materials with improved performance and durability. They work in manufacturing, making vaccines and antibiotics. They invent new ways to keep our food and water supplies safe. Opportunities for chemical engineers span numerous industries: pharmaceuticals, polymers, energy, food, consumer products, biotechnology, and electronic and optical materials. Graduates understand the needs of society, and use their training in science and technology to meet those needs.

The chemical engineering program develops the student’s capability for invention and analysis of chemical processes and products. Students in the program take several classes in chemistry, along with courses in physics, mathematics, and biology. The curriculum provides a rigorous education in the fundamental chemical engineering sciences of thermodynamics, transport phenomena, and kinetics, as well as more applied areas such as materials science, biochemical engineering, or chemical process design. Because engineers must be skilled communicators, the curriculum places considerable emphasis on technical report writing, team projects, and formal and informal oral presentation. In addition, students broaden their understanding of people and society by taking several courses in the humanities and social sciences.

The B.S. program in chemical engineering leads to a wide variety of careers. Graduates are prepared for professional lives in industry, government, engineering design, or consulting companies. Graduates with a more practical, hands-on approach are employed in manufacturing support, process development, product development, design, construction, or technical sales. They rapidly advance to responsible technical supervisory and management positions. Graduates with a research interest work to improve understanding of scientific engineering principles, and to apply these principles to solve emerging problems. Entrepreneurial graduates work in smaller enterprises, or create their own businesses, developing the major industries of tomorrow. An undergraduate degree in chemical engineering provides a strong basis for further training in medicine, law, or policy.

Admission to the College as a Freshman

Students applying to UW–Madison must declare an engineering major as their first choice in order to be considered for direct admission to the College of Engineering. Direct admission to a major means students will start in the program of their choice in the College of Engineering and will need to meet progression requirements at UW–Madison. Students apply to their intended engineering program by submitting the online application by stated deadlines for spring and fall. The College of Engineering offers a rigorous education in the fundamental chemical engineering sciences of thermodynamics, transport phenomena, and kinetics, as well as more applied areas such as materials science.

Cross-campus Transfer to Engineering

UW–Madison students in other schools and colleges on campus must meet the course and credit requirements for admission to engineering degree granting classifications specified in the general college requirements. The requirements are the minimum for admission consideration. Cross-campus admission is competitive and selective, and the grade point average expectations may increase as demand trends change. The student’s overall academic record at UW–Madison is also considered. Students apply to their intended engineering program by submitting the online application by stated deadlines for spring and fall. The College of Engineering offers group information sessions for students to learn about the cross-campus transfer process.

Off-campus Transfer to Engineering

With careful planning, students at other accredited institutions can transfer coursework that will apply toward engineering degree requirements at UW–Madison. Off-campus transfer applicants are considered for direct admission to the College of Engineering by applying to the Office of Admissions with an engineering major listed as their first choice. Those who are admitted to their intended engineering program must meet progression requirements. Transfer admission to the College of Engineering is competitive and selective, and students who have earned more than 80 transferable semester credits at the time of application are not eligible to apply.

Off-campus transfer students are encouraged to discuss their interests, academic background, and admission options with the Transfer Admissions and Advising Coordinator in the College of Engineering: ugtransfer@ engr.wisc.edu or 608-262-2473.

Second Bachelor’s Degree

The College of Engineering does not accept second undergraduate degree applications. Second degree students might explore the Biological Systems Engineering program at UW–Madison, an undergraduate engineering degree elsewhere, or a graduate program in the College of Engineering.

Requirements

University General Education Requirements

All undergraduate students at the University of Wisconsin–Madison are required to fulfill a minimum set of common university general education requirements to ensure that every graduate acquires the essential core of an undergraduate education. This core establishes a foundation for living a productive life, being a citizen of the world, appreciating aesthetic experience, and being equipped to excel in a variety of careers.
values, and engaging in lifelong learning in a continually changing world. Various schools and colleges will have requirements in addition to the requirements listed below. Consult your advisor for assistance, as needed. For additional information, see the university Undergraduate General Education Requirements (http://guide.wisc.edu/undergraduate/#requirementsforundergraduatestudytext) section of the Guide.

### Requirements Detail

**General Education**
- **Breadth—Humanities/Literature/Arts:** 6 credits
- **Breadth—Natural Science:** 4 to 6 credits, consisting of one 4- or 5-credit course with a laboratory component; or two courses providing a total of 6 credits
- **Breadth—Social Studies:** 3 credits
- **Communication Part A & Part B**
- **Ethnic Studies**
- **Quantitative Reasoning Part A & Part B**

* The mortarboard symbol appears before the title of any course that fulfills one of the Communication Part A or Part B, Ethnic Studies, or Quantitative Reasoning Part A or Part B requirements.

The following curriculum applies to students admitted to the chemical engineering degree program.

## SUMMARY OF REQUIREMENTS

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mathematics</strong></td>
<td></td>
<td>19</td>
</tr>
<tr>
<td><strong>Physics</strong></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td><strong>Chemistry</strong></td>
<td></td>
<td>20</td>
</tr>
<tr>
<td><strong>Life Science</strong></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td><strong>Core Engineering Requirement</strong></td>
<td></td>
<td>48</td>
</tr>
<tr>
<td><strong>Professional Breadth</strong></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td><strong>Communication Skills</strong></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td><strong>Liberal Studies Requirement</strong></td>
<td></td>
<td>16</td>
</tr>
<tr>
<td><strong>Free Electives</strong></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td><strong>Total Credits</strong></td>
<td></td>
<td>133</td>
</tr>
</tbody>
</table>

## MATHEMATICS REQUIREMENT

Transfer students must have equivalent math courses to meet the calculus requirement with a minimum of 12 credits to cover the three-course basic math sequence. Any deficiency in total math credits must be made up with electives in science or engineering.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mathematics</strong></td>
<td></td>
<td>19</td>
</tr>
<tr>
<td><strong>Physics</strong></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td><strong>Chemistry</strong></td>
<td></td>
<td>20</td>
</tr>
<tr>
<td><strong>Life Science</strong></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td><strong>Core Engineering Requirement</strong></td>
<td></td>
<td>48</td>
</tr>
<tr>
<td><strong>Professional Breadth</strong></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td><strong>Communication Skills</strong></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td><strong>Liberal Studies Requirement</strong></td>
<td></td>
<td>16</td>
</tr>
<tr>
<td><strong>Free Electives</strong></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td><strong>Total Credits</strong></td>
<td></td>
<td>133</td>
</tr>
</tbody>
</table>

## PHYSICS REQUIREMENT

Transfer students who receive fewer than 6 credits for the required courses must make up the credit shortage with another physics course.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physics</strong></td>
<td></td>
<td>10</td>
</tr>
</tbody>
</table>

## CHEMISTRY REQUIREMENT

Credit shortages cause by transfer of freshman chemistry courses at fewer than 9 credits must be made up with chemistry, biochemistry, or chemical engineering courses.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chemistry</strong></td>
<td></td>
<td>20</td>
</tr>
</tbody>
</table>

## LIFE SCIENCE

Students who meet the Introductory Biology requirement with an AP exam are encouraged to take two advanced biology electives.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LIFE SCIENCE</strong></td>
<td></td>
<td>6</td>
</tr>
</tbody>
</table>

## STATISTICS REQUIREMENT

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>STAT 324</strong></td>
<td>Introductory Applied Statistics for Engineers</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total Credits</strong></td>
<td></td>
<td>19</td>
</tr>
</tbody>
</table>

## REQUIREMENTS FOR VARIOUS PROGRAMS

### Advanced Biology Requirement (choose one)

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
</table>

## Total Credits

Total Credits: 133

1. BIOCORE 381 Evolution, Ecology, and Genetics and BIOCORE 383 Cellular Biology may be used to satisfy the Life Sciences Requirements.
CORE ENGINEERING REQUIREMENT

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBE 250</td>
<td>Process Synthesis</td>
<td>3</td>
</tr>
<tr>
<td>CBE 255</td>
<td>Introduction to Chemical Process Modeling</td>
<td>3</td>
</tr>
<tr>
<td>CBE 310</td>
<td>Chemical Process Thermodynamics</td>
<td>3</td>
</tr>
<tr>
<td>CBE 311</td>
<td>Thermodynamics of Mixtures</td>
<td>3</td>
</tr>
<tr>
<td>CBE/B M E 320</td>
<td>Introductory Transport Phenomena</td>
<td>4</td>
</tr>
<tr>
<td>CBE 324</td>
<td>Transport Phenomena Lab</td>
<td>3</td>
</tr>
<tr>
<td>CBE 326</td>
<td>Momentum and Heat Transfer Operations</td>
<td>3</td>
</tr>
<tr>
<td>CBE 424</td>
<td>Operations and Process Laboratory</td>
<td>5</td>
</tr>
<tr>
<td>CBE 426</td>
<td>Mass Transfer Operations</td>
<td>3</td>
</tr>
<tr>
<td>CBE 430</td>
<td>Chemical Kinetics and Reactor Design</td>
<td>3</td>
</tr>
<tr>
<td>CBE Electives 2</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Total Credits</td>
<td></td>
<td>48</td>
</tr>
</tbody>
</table>

Select one of the following:

- CBE 440 Chemical Engineering Materials
- CBE 540 Polymer Science and Technology
- CBE/E C E/ M S & E 544 Processing of Electronic Materials
- CBE 547 Introduction to Colloid and Interface Science
- CBE 450 Process Design
- CBE 470 Process Dynamics and Control
- CBE Electives 2

Total Credits 48

2 Chemical engineering electives may be chosen from any of the chemical engineering courses that are not required, with the exception of CBE/CHM/E M/A/M E 425 Undergraduate Rheology Seminar. A maximum of 2 credits of co-op work (CBE 1 Cooperative Education Program) may be applied to meet the CBE elective requirement. BSE/FOOD SCI 542 Food Engineering Operations and BSE/FOOD SCI 642 Food and Pharmaceutical Separations can be taken as CBE elective courses. Qualified undergraduates may take graduate-level (600 or 700) courses to fulfill this requirement. Engineering elective courses are to be selected from the College of Engineering (preferably outside chemical engineering). At least 1 of the 3 credits must be obtained from a list of approved courses in the CBE Curriculum Guide that carry engineering topics credits. A maximum of 6 credits of CBE 599 Special Problems and/or CBE 699 Advanced Independent Studies may be used to satisfy the 9-credit sequence of CBE and engineering elective courses.

PROFESSIONAL BREADTH

Select 6 credits

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professional Breadth Credits 3</td>
<td></td>
<td>6</td>
</tr>
</tbody>
</table>

Courses 300+ from the following College of Engineering departments and programs may be used:

- Biomedical Engineering
- Civil and Environmental Engineering
- Electrical and Computer Engineering
- Engineering Mechanics and Astronautics

Engineering Professional Development (200 level and higher)

- Geological Engineering
- Industrial Engineering
- Interdisciplinary Courses (200 level and higher)
- Materials Science and Engineering
- Mechanical Engineering
- Nuclear Engineering
- Engineering Physics

Courses 300+ from the following departments in the College of Letters and Sciences may be used:

- Chemistry
- Computer Sciences
- Math
- Physics

The following courses may also be used:

- ACCT I S 300 Accounting Principles
- MICROBIO 303 Biology of Microorganisms
- BIOCHEM 501 Introduction to Biochemistry
- BIOCHEM 507 General Biochemistry I
- BIOCORE 381 Evolution, Ecology, and Genetics
- BIOCORE 383 Cellular Biology
- BSE/FOOD SCI 642 Food and Pharmaceutical Separations
- ECON/A A E/ ENVIR ST 343 Environmental Economics
- ENVIR ST/ PHILOS 441 Environmental Ethics
- FINANCE/ ECON 300 Introduction to Finance
- GENETICS 466 Principles of Genetics
- HIST SCI 337 History of Technology
- STAT/M E 424 Statistical Experimental Design
- ZOOLOGY 570 Cell Biology

Total Credits 6

Students may petition the department to allow other courses related to engineering professional practice. To request that a course not listed above be used, the student should fill out the Professional Breadth Requirement Course Request form available online and submit it to the advisor. The department will then determine if the course can be counted toward the Professional Breadth Requirement. Petitions must be submitted before the beginning of the semester in which the course is to be taken.

3 The objective of this requirement is to provide students with skills to interact with professionals from other disciplines. Suitable courses for this requirement include courses in engineering (excluding CBE) and science, as well as a variety of other disciplines.

4 Full degree credit is not allowed if a student takes both CBE 440 Chemical Engineering Materials and M S & E 350 Introduction to Materials Science. In this case M S & E 350 will be awarded only 1 degree credit.
COMMUNICATION SKILLS

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGL 100</td>
<td>Introduction to College Composition</td>
<td>3</td>
</tr>
<tr>
<td>or COM ARTS 100</td>
<td>Introduction to Speech Composition</td>
<td></td>
</tr>
<tr>
<td>or LSC 100</td>
<td>Science and Storytelling</td>
<td></td>
</tr>
<tr>
<td>or ESL 118</td>
<td>Academic Writing II</td>
<td></td>
</tr>
</tbody>
</table>

5 For Part A of the General Education Communication Requirement (2 cr) students must select one course with an “a” designation in “g” of the “geBLC” information in the Course Guide. Some students will be exempt from this requirement based on their placement test scores or advanced placement in English. CBE 424 Operations and Process Laboratory satisfies Part B of the General Education Communication Skills Requirement.

LIBERAL STUDIES ELECTIVES

Students must complete 16 credits of liberal studies according to the College of Engineering requirements.6

6 1. Liberal studies elective courses must be classified as either Humanities, Social Studies, or Literature courses (identified by the letters H, S, L, or Z in “B” of the “geBLC” information in the Course Guide). At least 6 credits must have a breadth designation of Humanities (H, L, or Z), and at least 3 credits must have a designation of Social Studies (S or Z). Foreign language courses count as H credits.
2. A 3-credit ethnic studies course must be selected from the College of Letters & Science. Acceptable courses are identified by the letter “e” in the Course Guide. If appropriate, the ethnic studies course may be among those used to satisfy the concentration requirement.
3. Retroactive credits may be awarded for foreign-language work done in high school. The following conditions apply:
   • A university-level foreign language course must be taken before the student has earned 30 college credits in residence.
   • Retroactive Language Credit Request Form must be completed and submitted to the language instructor during the first two weeks of class.
   • The student must earn a B or better in this course.
   • Such credits do not count toward the 16 liberal-studies credits required. They may, however, be used to satisfy the concentration and depth requirements stated in item 2 above and count as degree credits.
4. English composition courses, English as a second language courses, and basic communications arts courses are not accepted as liberal studies electives.

FREE ELECTIVES

Students can choose any combination of courses totaling 6 credits.7

7 Students who satisfy the Communications Part A requirement by examination will have an additional 2 credits of free electives. Transfer students who receive fewer transfer credits for a required course than are given for the same course on the Madison campus must increase their free elective credits to meet the minimum 133 total credit requirement for the chemical engineering degree.

COURSE SUBSTITUTION REGULATIONS

1. Any student may, with advisor approval, replace up to 12 credits of required courses in the curriculum, except CBE 424 Operations and Process Laboratory, by an equal number of credits of other courses within the limitations listed under (3) below.
2. Any student who wishes to amend the curriculum by more than 12 credits or wishes to appeal the advisor’s decision in (1) or to request exception to (3) below must submit a written request to the chair of the department, who will bring it to the department faculty for consideration.
3. Restrictions on course substitutions are as follows:
   a. Physics course may be replaced by science or engineering courses.
   b. Chemistry/life science courses must be replaced by courses with significant chemistry/life science content.
   c. Engineering courses must be replaced by engineering courses.
   d. Lab courses must be replaced by courses with an equal number of hours of lab courses.
   e. English as a second language courses, and MATH 112, MATH 113 and MATH 114 may not be used for course substitutions.

UNIVERSITY DEGREE REQUIREMENTS

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Degree</td>
<td>To receive a bachelor’s degree from UW–Madison, students must earn a minimum of 120 degree credits. The requirements for some programs may exceed 120 degree credits. Students should consult with their college or department advisor for information on specific credit requirements.</td>
</tr>
<tr>
<td>Residency</td>
<td>Degree candidates are required to earn a minimum of 30 credits in residence at UW–Madison. “In residence” means on the UW–Madison campus with an undergraduate degree classification. “In residence” credit also includes UW–Madison courses offered in distance or online formats and credits earned in UW–Madison Study Abroad/Study Away programs.</td>
</tr>
<tr>
<td>Quality of Work</td>
<td>Undergraduate students must maintain the minimum grade point average specified by the school, college, or academic program to remain in good academic standing. Students whose academic performance drops below these minimum thresholds will be placed on academic probation.</td>
</tr>
</tbody>
</table>

LEARNING OUTCOMES

At the time of graduation, UW–Madison Chemical Engineering students will have attained:

a. an ability to apply knowledge of mathematics, science, and engineering.
b. an ability to design and conduct experiments, as well as to analyze and interpret data.
c. an ability to design a system, component, or process to meet desired needs within realistic constraints.
d. an ability to function on multi-disciplinary teams.
e. an ability to identify, formulate, and solve engineering problems.
f. an understanding of professional and ethical responsibility.
g. an ability to communicate effectively.
h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
Chemical Engineering, B.S.

i. a recognition of the need for, and an ability to engage in life-long learning.

j. a knowledge of contemporary issues.

k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

l. ability with engineering application of the basic sciences to the design, analysis, and control of chemical, physical, and biological processes, including the hazards associated with these processes.

FOUR-YEAR PLAN

SAMPLE FOUR-YEAR PLAN

First Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Credits</th>
<th>Spring</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 109</td>
<td>5 CHEM 329</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>MATH 221</td>
<td>5 MATH 222</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>INTEREG 110</td>
<td>1 PHYSICS 201</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Communications</td>
<td>3 Liberal Studies</td>
<td>Elective</td>
<td>3</td>
</tr>
<tr>
<td>Liberal Studies</td>
<td>3 Elective</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>16</td>
<td></td>
</tr>
</tbody>
</table>

Second Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBE 250¹</td>
<td>3 CBE 255</td>
</tr>
<tr>
<td>CHEM 343²</td>
<td>3 MATH 320 or 319</td>
</tr>
<tr>
<td>MATH 234</td>
<td>4 CBE 310</td>
</tr>
<tr>
<td>PHYSICS 202</td>
<td>5 CHEM 345</td>
</tr>
<tr>
<td>ZOOLOGY 153</td>
<td>3 STAT 324</td>
</tr>
<tr>
<td></td>
<td>18</td>
</tr>
</tbody>
</table>

Third Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBE 311</td>
<td>3 CBE 326</td>
</tr>
<tr>
<td>CBE/B M E 320¹</td>
<td>4 CBE 324</td>
</tr>
<tr>
<td>Professional Breadth Elective</td>
<td>3 CHEM 562</td>
</tr>
<tr>
<td>Advanced Biology Elective</td>
<td>3 Professional Breadth Elective</td>
</tr>
<tr>
<td>Liberal Studies Elective</td>
<td>3 Liberal Studies Elective</td>
</tr>
<tr>
<td></td>
<td>16</td>
</tr>
</tbody>
</table>

Fourth Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBE 426</td>
<td>3 CBE 450</td>
</tr>
<tr>
<td>CBE 430</td>
<td>3 CBE 470</td>
</tr>
<tr>
<td>CBE Elective</td>
<td>3 CBE Elective</td>
</tr>
<tr>
<td>Materials Elective</td>
<td>3 Free Elective</td>
</tr>
</tbody>
</table>

Total Credits 133

¹ CBE 250 Process Synthesis and CBE/B M E 320 Introductory Transport Phenomena both require a grade of C or better.
² CHEM 343 Introductory Organic Chemistry requires a grade of C or better.

ADVISORY AND CAREERS

ADVISING

Each College of Engineering program has academic advisors dedicated to serving its students. Program advisors can help current College of Engineering students with questions about accessing courses, navigating degree requirements, resolving academic issues and more. Students can find their assigned advisor on the homepage of their student center.

ENGINEERING CAREER SERVICES

Engineering Career Services (ECS) assists students in identifying pre-professional work-based learning experiences such as co-ops and summer internships, considering and applying to graduate or professional school, and finding full-time professional employment during their graduation year.

ECS offers two major career fairs per year, assists with resume writing and interviewing skills, hosts workshops on the job search, and meets one-on-one with students to discuss offer negotiations.

Students are encouraged to utilize the ECS office early in their academic careers. For comprehensive information on ECS programs and workshops, see the ECS website or call 608-262-3471.

PEOPLE

Professors Abbott, Dumesic, Graham, Huber, Klingenberg, Kuech, Lynn, Maravelias, Mavrikakis (Chair), Murphy, Palacek, Rawlings, Root, Shusta, Yin; Associate Professors Pfleger, Reed, Swaney; Assistant Professors Van Lehn, Zavala Tejada