

University of Wisconsin-Madison  
Department of Chemical and Biological  
Engineering

2009 Curriculum Guide for  
Chemical Engineering Undergraduates

The following curriculum applies to students admitted to the Chemical Engineering degree classification September 2009 or later.

# Chemical Engineering Curriculum

## Requirement Summary

Mathematics, 19 cr

Physics, 10 cr

Chemistry, 20 cr

Life Science, 6 cr

Engineering, 48 cr

Communication Skills, 2 cr

Liberal Studies, 16 cr

Free Electives, 6 cr

Professional Breadth, 6 cr

Total Credits: 133

### I. Mathematics, 19 cr<sup>1</sup>

Math 221 Calculus and Analytic Geometry, 5 cr<sup>2</sup>

Math 222 Calculus and Analytic Geometry, 5 cr

Math 234 Calculus -- Functions of Several Variables, 3 cr

Math 319 Techniques in Ordinary Differential Equations, 3 cr,  
or Math 320 Linear Algebra and Differential Equations, 3 cr

Statistics 324 Introductory Applied Statistics for Engineers, 3 cr

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### II. Science, 36 cr

#### A. Physics, 10 cr

Physics 201 or 207 General Physics, 5 cr

Physics 202 or 208 General Physics, 5 cr

Transfer students who receive fewer than 6 credits for Physics 201/202 or 207/208 courses must make up the credit shortage with another Physics course.

#### B. Chemistry, 20 cr

Chem 109 General and Analytical Chemistry I, 5 cr<sup>3</sup>

Chem 329 Fundamentals of Analytical Science, 4 cr

Chem 343 Introductory Organic Chemistry, 3 cr

Chem 344 Introductory Organic Chemistry Lab, 2 cr

Chem 345 Intermediate Organic Chemistry, 3 cr

Chem 562 Physical Chemistry, 3 cr

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<sup>1</sup>Transfer students must have equivalent math courses to meet the requirement of the three basic calculus courses with at least 12 credits.

<sup>2</sup>Meets the Quantitative Reasoning, Part A General Education Requirement.

<sup>3</sup>Meets the Quantitative Reasoning, Part B and Natural Science General Education Requirement.

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Transfer students whose general chemistry courses do not contain significant analytical chemistry content must take Chemistry 329 (or Chemistry 327). Credit shortages caused by transfer of freshman chemistry courses at fewer than 9 credits must be made up with chemistry, biochemistry or chemical engineering courses.

### C. Life Science, 6 cr

*Introductory Biology requirement:* Zool 153 (3 cr) or Zool 151 (5 cr) or score of 5 on AP Biology Exam

*Advanced Biology requirement:* Biochem 501 (3 cr) or Biochem 507 (3 cr) or Zool 570 (3 cr) or Gen 466 (3 cr) or Bact 303 (3 cr)

Biocore 301 and 303 may be used to satisfy the Life Science requirements. Students who meet the Introductory Biology requirement with an AP exam are encouraged to take 2 advanced biology electives.

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### IV. Engineering, 48 cr

CBE 250 Process Synthesis, 3 cr

CBE 255 Introduction to Chemical Process Modeling, 3 cr

CBE 310 Chemical Process Thermodynamics (formerly CBE 211), 3 cr

CBE 311 Thermodynamics of Mixtures, 3 cr

CBE 320 Introductory Transport Phenomena, 4 cr

CBE 324 Transport Phenomena Lab, 3 cr

CBE 326 Momentum and Heat Transfer Operations, 3 cr

CBE 424 Operations and Process Laboratory, 5 cr<sup>4</sup>

CBE 426 Mass Transfer Operations, 3 cr

CBE 430 Chemical Kinetics and Reactor Design, 3 cr

Materials Elective (CBE 440 Chemical Engineering Materials, 3 cr

or CBE 540 Polymer Science and Technology, 3 cr

or CBE 544 Processing of Electronic Materials, 3 cr

or CBE 547 Introduction to Colloid and Interface Science, 3cr)

CBE 450 Process Design, 3 cr

CBE 470 Process Dynamics and Control, 3 cr

CBE Electives, 6 cr

Chemical Engineering electives may be chosen from any of the chemical engineering courses that are not required, **with the exception of CBE 425**. A maximum of two credits of co-op work (CBE 001) may be used to meet the CBE elective requirement. BSE 542, Food Engineering Operations, and BSE 642, Food & Pharmaceutical Separations, can be taken as CBE elective courses. Qualified undergraduates may take graduate-level (600 or 700) courses to fulfill this requirement.

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<sup>4</sup>Meets the Communication Skills, Part B General Education Requirement.

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### V. Professional Breadth Requirement, 6 cr

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. A list of approved courses is available via <http://www.engr.wisc.edu/che/current/undergrad/>. A recent version of this list is appended.

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### VI. Communications Skills Requirements<sup>5</sup>

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” column of the Timetable, such as the following: Ag Journ 100, Comm Arts 100, EPD 155, English 100, ILS 200, or Family Comm 100. English 118 is also approved for those students required to study English as a second language. Some students will be exempt from this requirement based on their placement test scores or advanced placement in English.

CBE 424 satisfies Part B of the General Education Communication Skills Requirement.

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### VII. Liberal-Studies Requirements, 16 cr<sup>6</sup>

- 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” column of the Timetable). 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) Among the liberal-studies electives 9-12 credits must be chosen to form a concentration in one field or two closely related fields, and at least one of the courses in the concentration must be at an intermediate or advanced level (indicated by an **I, A** or **D** in the “L” of the “geBLC” column of the Timetable).
- 3) A minimum of 4 credits must be taken outside the field of concentration.

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<sup>5</sup>Meets the Communication Skills Part A and Part B General Education Requirement.

<sup>6</sup>Meets the Humanities/Literature/Arts and Social Studies General Education Requirement.

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- 4) A 3-credit ethnic-studies course must be selected from the College of Letters and Science. Acceptable courses are identified by the letter "e" in the "eBLC" column of the Timetable. If appropriate, the ethnic-studies course may be among those used to satisfy the concentration requirement.
- 5) Retroactive credits may be awarded for foreign language work done in high school. The following conditions apply:
  - a) A university-level foreign language course must be taken before the student has earned 30 college credits in residence;
  - b) A Retroactive Language Credit Request Form must be completed and submitted to the language instructor during the first two weeks of class;
  - c) The student must earn a B or better in this course.

Such credits do not count towards 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.

- 6) English composition courses, English as a Second Language courses, and basic Communications Arts courses are not accepted as liberal-studies electives.

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### **VIII. Free Electives, 6 cr**

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.

## General College Requirements and the Chemical Engineering Curriculum

Prior to admission to a degree-granting program, students must complete several General College Requirements (GCR; see <http://studentservices.engr.wisc.edu/current/>). As part of the GCR, students must take courses in 5 categories (Communications, Physics, Chemistry, Introduction to Engineering, and Mathematics). While various courses can be selected in these categories, students who wish to be admitted to Chemical Engineering are **strongly encouraged** to take the specific courses listed in the table below.

General College Requirement	Recommended Course
1. Comm A (General Education Requirement)	EPD 155 (2cr) <sup>(1)</sup>
2. Physics	Phys 201 (5cr) <sup>(2)</sup>
3. Chemistry	Chem 109 (5cr) <sup>(3)</sup>
4. Introduction to Engineering	InterEGR 101 (2cr), 102 (2cr) or 160 (3cr) <sup>(4)</sup>
5. Mathematics	Math 221 (5cr) and Math 222 (5cr) <sup>(5)</sup>

(1) Any Comm A course may be taken.

(2) EMA 201 (3cr) + EMA 202 (3cr) may be substituted for Phys 201.

(3) Chem 103 (4cr) + Chem 104 (5cr) may be substituted for Chem 109.

(4) InterEGR 101 and 102 can count toward the departmental free elective or liberal elective requirements; InterEGR 160 can count toward the departmental professional breadth requirement. Other Introduction to Engineering courses approved for the GCR (see <http://studentservices.engr.wisc.edu/current/>) can count toward the free elective requirements.

(5) Math 217 (5cr) may be substituted for Math 221; Math 275 (5cr) + Math 276 (5cr) may be substituted for Math 221 + Math 222.

These recommended courses present the preferred topics at a level suitable for Chemical Engineering students. Other alternatives that satisfy the General College Requirements will be accepted for admission into the Chemical Engineering degree program, but these choices may reduce the number of free electives available in the curriculum.

## **Recommended Course Sequence (Prerequisites are shown in parentheses)**

### **Freshman year, First semester, 15 credits**

Chem 109 General and Analytical Chemistry, 5 cr  
Math 221 Calculus and Analytic Geometry, 5 cr  
Communications Elective, 2 cr  
Liberal Studies Elective, 3 cr

### **Freshman year, Second Semester, 17 credits**

Chem 329 Fundamentals of Analytical Science, 4 cr (Chem 109 or cons inst)  
Math 222 Calculus and Analytic Geometry, 5 cr (Math 221)  
Physics 201 General Physics, 5 cr (Math 221 or cons inst)  
Liberal Studies Elective, 3 cr

### **Sophomore year, First semester, 17 credits**

CBE 250 Process Synthesis, 3 cr (Chem 329, or con reg)  
Chem 343 Introductory Organic Chemistry, 3 cr (Chem 104 or 109)  
Math 234 Calculus -- Functions of Several Variables, 3 cr (Math 222)  
Physics 202 General Physics, 5 cr (Physics 201 or equiv.)  
Zool 153 Introductory Biology, 3 cr (Chem 109)

### **Sophomore year, Second Semester, 17 credits**

CBE 255 Introduction to Chemical Process Modeling, 3 cr (Math 319 or 320 or con reg)  
CBE 310 Chemical Process Thermodynamics, 3 cr (Math 234, Physics 201 or equiv; CBE 255 or equiv or con reg; CBE 250 with grade of C or better)  
Chem 344 Introductory Organic Chemistry Lab, 2 cr (Chem 341 or 343)  
Chem 345 Intermediate Organic Chemistry, 3 cr (Chem 343 with grade of C or better)  
Math 319 Techniques in Ordinary Differential Equations. 3cr, (Math 222)  
or Math 320 Linear Algebra and Differential Equations, 3 cr (Math 222)  
Stat 324 Intro Applied Statistics for Engineers, 3 cr (Math 222)

### **Junior year, First semester, 16 credits**

CBE 320 Introductory Transport Phenomena, 4 cr (Physics 201, Math 319 or 320, CBE 250 with grade of C or better; or cons inst)  
CBE 311 Thermodynamics of Mixtures, 3 cr (CBE 310 with grade of C or better)  
Advanced Biology Elective, 3 cr  
Liberal Studies Elective, 3 cr  
Professional Breadth Elective, 3 cr

### **Junior year, Second Semester, 16 credits**

CBE 324 Transport Phenomena Lab, 3 cr (CBE 310 & 320 or con reg; Stat 324)  
CBE 326 Momentum and Heat Transfer Operations, 3 cr (CBE 310 & 320 with grades of C or better)  
Chem 562 Physical Chemistry, 3 cr (CBE 310, Physics 202)  
Liberal Studies Elective, 4 cr  
Professional Breadth Elective, 3 cr

## **Recommended Course Sequence (Continued)**

### **Senior year, First semester, 15 credits**

CBE 426 Mass Transfer Operations, 3 cr (CBE 311 & 320 with grades of C or better)

CBE 430 Chemical Kinetics and Reactor Design, 3 cr (CBE 311 & 320 or cons inst.)

CBE 440 Chemical Engineering Materials, 3 cr (Chem 345)

or CBE 540 Polymer Science and Technology, 3cr (Chem 345; CBE 326 & 430, or con reg;  
Stat 324; or cons inst)

or CBE 544 Processing of Electronic Materials, 3 cr (CBE 440 or MS&E 351 or ECE 335;  
or cons inst)

or CBE 547 Introduction to Colloid and Interface Science, 3r (Chem 561 or 562 or equiv,  
or cons inst)

CBE Elective, 3 cr

Liberal Studies Elective, 3 cr

### **Senior year, Second Semester, 15 credits**

CBE 450 Process Design, 3 cr (CBE 326, 426 & 430 or cons inst)

CBE 470 Process Dynamics and Control, 3 cr (CBE 326; CBE 430 or con reg)

CBE Elective, 3 cr

Free Elective, 6 cr

### **Senior year, Summer session, 5 credits**

CBE 424 Operations and Process Lab, 5 cr (CBE 324, 326, 426 & 430; or cons inst.)

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## Elective Course Lists

### **I. Communication Part A**

Ag Journ 100, Communication in Agricultural and Life Sciences, Sem. I, II; 3 cr.

Comm Arts 100, Introduction to Speech Composition Sem. I, II; 3 cr.

EPD 155, Basic Communication, Sem. I, II, SS; 2 cr.

English 100, Freshman Composition, Sem. I, II; 3 cr.

English 118, English as a 2nd Language; Composition, Sem I, II, SS; 3 cr.

Fam Com 100, Intro to Communication; Inquiry and Exposition, Sem. I, II, 3 cr.

Integ Lib Std 200, Critical Thinking and Expression, Sem. I; 3 cr.

### **II. Professional Breadth Elective Courses**

For the most up-to-date list of courses, see <http://www.engr.wisc.edu/che/current/undergrad/>.

- A. Courses of level 300 or higher 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<sup>1</sup>
- Geological Engineering
- Industrial Engineering
- Interdisciplinary Courses (Engineering)<sup>1</sup>
- Materials Science and Engineering<sup>2</sup>
- Mechanical Engineering
- Nuclear Engineering
- Engineering Physics

- B. Biological Systems Engineering - BSE 542, Food Engineering Operations, and BSE 642, Food and Pharmaceutical Separations, may be used.

- C. Any course of level 300 or higher from the following departments in the College of Letters and Sciences may be used:

- Chemistry
- Computer Sciences
- Math
- Physics

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<sup>1</sup> InterEgr 160, and any other course of level 200 or higher.

<sup>2</sup> Full degree credit is not allowed if a student takes both CBE 440 and MS&E 350. MS&E 350 will be awarded only 1 degree credit.

- D. The following courses may also be used:

Econ 343 Environmental Economics  
Envir St 343 Environmental Economics  
Envir St/Phil 441 Environmental Ethics  
Hist Sci 337 History of Technology  
Stat 424 Experimental Design  
Biochem 501 Introduction to Biochemistry  
or Biochem 507 General Biochemistry  
Zool 570 Cell Biology  
Gen/Botany/Zool 466 General Genetics  
Bact 303 Biology of Microorganisms  
Biocore 301 Evolution, Ecology and Genetics  
Biocore 303 Cell Biology  
Acct IS 300 Accounting Principles  
Finance 300 Introduction to Finance

Students may petition the department to allow other courses related to engineering professional practice. To request that a course that is not listed above be used, the student should fill out the Professional Breadth Requirement Course Request form on the following page (also available online via <http://www.engr.wisc.edu/che/current/undergrad/>) and submit it to his/her advisor. The department will then decide if the course can be counted toward the Professional Breadth Requirement.

## Professional Breadth Elective Course Request form

Department:

Course number:

Course title:

Credits:

Prerequisites:

Course catalogue description:

Rationale:

Student's name: \_\_\_\_\_

Advisor's signature: \_\_\_\_\_

## **Curriculum Specialization for Chemical Engineering**

Students wishing to specialize or to prepare for graduate study in technical or nontechnical areas may use electives and the course substitution regulations to achieve a curriculum that will enhance professional development in a particular specialty. Examples for several technical areas are listed below. Students should consult their advisers regarding additional substitutions.

### **Bioprocess Engineering**

CBE 440/540: CBE 540

CBE elective: CBE 560, BSE 542, 642

Free elective: Genetics 466, Food Sci 550

### **Biomedical and Premedical**

CBE 440/540: CBE 540

CBE elective: CBE 560

Breadth elective: BME 315, 401, 410, 430

### **Environmental Engineering**

CBE 440/540: CBE 440

CBE elective: CBE 567, 535

Breadth elective: CEE 320, 326, 521, 522

Free elective: Envir St. 343, Geol 411

### **Polymers**

CBE 440/540: CBE 440

CBE elective: CBE 540, 541, 525

Breadth elective: ME 417, 418

### **Food Engineering**

CBE 440/540: CBE 440

CBE elective: CBE 540, 565

Breadth elective: CEE 521, 320, BSE 642

Free elective: Food Sci 410

### **Process Systems Engineering**

Breadth elective: IE 313, 433, CS 412,513

Free elective: Math 340, 415

### **Solid State Materials**

CBE 440/540: CBE 440

CBE elective: CBE 544

Breadth elective: MSE 448, 570, ECE 335, 466

Free elective: Physics 531, 551

## **Appendix A**

### **Course Substitution Regulations**

#### **CBE Course Substitution Regulations**

1. Any student may, with adviser approval, replace up to 12 credits of required courses in the curriculum (except CBE 424) by an equal number of credits of other courses within the limitations listed under (3).
2. Any student who wishes to amend the curriculum by more than 12 credits or wishes to appeal the adviser's decision in (1) or to request exception to (3) below must submit a written request to the chairperson of the department, who will bring it to the department faculty for consideration.
3. Restrictions on course substitutions are the following:
  - a. Physics courses 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 an equal number of hours of lab courses;
  - e. English 101, English as a second language courses, and Math 112-114 may not be used for course substitutions.
4. A student who wishes to make a course substitution must obtain a **Course Substitution Form** from room 2035. The form must be signed by the student's adviser and turned into the Undergraduate Office, Room 2035, for entry into the student's record.

## Appendix B Pass/Fail Regulations

Pass/Fail Regulations applicable to Chemical Engineering undergraduate students:

1. Students in good standing may count toward an undergraduate degree two pass/fail courses. These courses must be liberal or free electives. (See paragraph 13, College of Engineering regulations regarding enrollment, scholarship and graduation for undergraduates, April 1985).
2. Only one “introductory” course taken on a pass/fail basis can be counted toward degree requirements. An introductory course is defined as one which requires only freshman or sophomore standing and no other college level course as a prerequisite.
3. Pass/Fail Requests can be accessed through your Student Center in My UW Madison (<http://my.wisc.edu>) by clicking on the 'Course Change Request' link via Course Enrollment, Term Information sub tab. Requests should be submitted before the end of the fourth week of classes. The pass/fail election may be withdrawn anytime before the end of the fourth week of classes.
4. A grade of “C” shall be the minimum acceptable for “Pass”. Pass/fail grades are not included in the calculation of the grade point average or the point credit ratio.
5. All students are free at any time to take courses in excess of degree requirements on a pass/fail basis.

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**Note:** Item 2 is a specific regulation of the Department of Chemical and Biological Engineering. All of the remaining items are regulations of the College of Engineering or the University.