DEPARTMENT OF CHEMICAL AND BIOLOGICAL ENGINEERING

INFORMATION FOR MAJORS IN CHEMICAL ENGINEERING

Fall 2020
Updated July 2020
Chemical Engineering Curriculum - Prerequisite Flowchart

Freshman
- Engineering Analysis
- Math
- Chem
- DTC
- Speech
- Theme

Sophomore
- ChE 210*, 211
- ChE 212
- Organic Chem
- Physics
- Mat Sci
- Theme

Junior
- ChE 321, 322
- ChE 323
- ChE 307
- Stats
- ChE 275
- Tech Electives

Senior
- ChE 341, 342, 351, 352
- Tech Electives

*Sophomore year has two variants; ChE 210 may be taken in sophomore or freshman year.

Total Requirements - 48 classes

Basic Courses:
A. Mathematics - 4 classes
   - MATH 220-1 (220)
   - MATH 228-1 (230)
   - MATH 220-2 (224)
   - MATH 228-2 (234)
B. Engineering Analysis - 4 classes
   - GEN ENG 205
C. Basic Sciences - 4 classes
   - PHYSICS 135-2,3 (plus labs)
   - CHEM 131,132, or 151,152, or 171,172 (plus labs)
D. Design and Communication - 3 classes
   - ENGLISH & DSGN 106-1,2
   - COMM ST (Speech) 102, or PERF ST (Performance) 103 or 203
E. Basic Engineering - 5 classes
   - CHEM ENG 210
   - CHEM ENG 211
   - MAT SCI 301
   - CHEM ENG 312 or IEMS 303
   - CHEM ENG 321

Distribution Requirements:
F. Social Sci/Humanities (Theme) - 7 classes
G. Unrestricted Electives - 5 classes

Core Curriculum:
H. Major Program – 11 required classes + 5 technical electives
   - CHEM 210-1: Organic Chemistry
   - CHEM 210-2: Organic Chemistry (plus lab)
   - CHEM ENG 212: Phase Equilibrium and Staged Separations
   - CHEM ENG 275: Cell & Molecular Biology for Engineers or BIOL SCI 215 or 291 or 201 or 202
   - CHEM ENG 307: Kinetics & Reactor Engineering
   - CHEM ENG 322: Heat Transfer
   - CHEM ENG 323: Mass Transfer
   - CHEM ENG 341: Dynamics and Control of Chemical and Biological Processes
   - CHEM ENG 342: Chemical Engineering Lab
   - CHEM ENG 351: Process Economics, Design & Evaluation
   - CHEM ENG 352: Chemical Engineering Design Projects

Technical Electives - 5 classes

You may choose an area of specialization: (OR follow technical elective guidelines - Section IIIB)

Bioengineering, Chemical Process Engineering, Design, Environmental Engineering and Sustainability,
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I. INTRODUCTION TO CHEMICAL ENGINEERING

Welcome to Chemical Engineering!

Chemical Engineering is a unique major that exists at the intersection of science and engineering. Building on a foundation of chemistry, biology, physics, and mathematics, the chemical engineering program expands student expertise to thermodynamics, transport processes, and chemical kinetics. Our curriculum provides students with the core chemical engineering fundamentals, while offering options to specialize in bioengineering, environmental engineering and sustainability, polymer science and engineering, design, process engineering, or nanotechnology and molecular engineering. In addition, students in the program have the opportunity to participate in a wide range of activities while on campus, including undergraduate research, co-op or internship, minors or certificates, study abroad, and student organizations.

Graduates of the undergraduate program in Chemical Engineering will

1. Behave ethically and consider the social implications of their work, especially as it affects the health, safety, and environment of citizens worldwide.

2. Think critically and creatively, especially about the use of technology to address local and global problems.

3. Be leaders in their chosen fields.

4. Excel in engineering practice, research, and management in industries based on chemistry and biology, such as the chemical, energy, advanced materials, microelectronics, pharmaceutical, biotechnology, and consumer products industries.

5. Apply their broad chemical engineering training to excel in areas such as entrepreneurship, medicine, law, government, and education.

6. Excel in top-ranked graduate programs and professional schools.

This document lists the degree requirements for chemical engineering undergraduates in the McCormick BS Program. Students may plan their coursework using the sample course sequence provided. Additional details are available about major requirements, the Biotechnology minor, the Honors Program, and student research opportunities.
II. BASIC SCIENCE, MATH, ENGINEERING, AND NON-TECHNICAL COURSES

A. Mathematics (4 classes)

These mathematics courses build up foundational skills that are necessary for engineering.

<table>
<thead>
<tr>
<th>Class Number</th>
<th>Class Title</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 220-1 (220)*</td>
<td>Differential Calculus of One Variable</td>
<td>Freshman</td>
</tr>
<tr>
<td>MATH 220-2 (224)*</td>
<td>Integral Calculus of One Variable</td>
<td>Freshman</td>
</tr>
<tr>
<td>MATH 228-1 (230)*</td>
<td>Multivariable Differential Calculus</td>
<td>Freshman</td>
</tr>
<tr>
<td>MATH 228-2 (234)*</td>
<td>Multiple Integration and Vector Calculus</td>
<td>Sophomore</td>
</tr>
</tbody>
</table>

Honors (by invitation):

<table>
<thead>
<tr>
<th>Class Number</th>
<th>Class Title</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESAM 252-1</td>
<td>Substitutes MATH 228-1 (230)*</td>
<td>Freshman</td>
</tr>
<tr>
<td>ESAM 252-2</td>
<td>Substitutes MATH 228-2 (234)*</td>
<td>Freshman</td>
</tr>
</tbody>
</table>

* Math department has changed the course numbers beginning in Fall 2019. Old numbers are in parentheses.

B. Basic Sciences (4 classes)

These basic chemistry and physics courses provide scientific background on which the chemical engineering curriculum builds.

<table>
<thead>
<tr>
<th>Class Number</th>
<th>Class Title</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 110**</td>
<td>Quantitative Problem Solving in Chemistry</td>
<td>Freshman</td>
</tr>
<tr>
<td>CHEM 131**</td>
<td>General Chemistry 1</td>
<td>Freshman</td>
</tr>
<tr>
<td>CHEM 132**</td>
<td>General Chemistry 2</td>
<td>Freshman</td>
</tr>
</tbody>
</table>

OR

<table>
<thead>
<tr>
<th>Class Number</th>
<th>Class Title</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 151**</td>
<td>Accelerated General Chemistry 1</td>
<td>Freshman</td>
</tr>
<tr>
<td>CHEM 152**</td>
<td>Accelerated General Chemistry 2</td>
<td>Freshman</td>
</tr>
</tbody>
</table>

OR

<table>
<thead>
<tr>
<th>Class Number</th>
<th>Class Title</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 171**</td>
<td>Advanced General Inorganic Chemistry</td>
<td>Freshman</td>
</tr>
<tr>
<td>CHEM 172**</td>
<td>Advanced General Physical Chemistry</td>
<td>Freshman</td>
</tr>
</tbody>
</table>

AND

<table>
<thead>
<tr>
<th>Class Number</th>
<th>Class Title</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYSICS 135-2**</td>
<td>General Physics - Electricity and Magnetism</td>
<td>Sophomore</td>
</tr>
<tr>
<td>PHYSICS 135-3**</td>
<td>General Physics – Intro to Modern Physics; Waves</td>
<td>Sophomore</td>
</tr>
</tbody>
</table>

* - Taken as an unrestricted elective for students completing the Chem 131, 132 sequence.

** Chemistry and Physics require concurrent enrollment in the laboratory courses.
*** IMPORTANT: If you enroll in one of the chemistry courses, the full chemistry sequence (131, 132; or 151, 152; or 171,172) must be completed, or you will be unable to register for Chem 210-1. This applies regardless of whether you have AP credits for General Chemistry.

**Grades:** Students who are unable to complete the freshman chemistry sequence with laboratory in their first year with all grades of "C-" or above are automatically behind in their schedule as CHEM 210-1 Organic Chemistry (usually taken in the sophomore year) requires as prerequisites grades of "C-" or better in all freshman chemistry courses.

C. **Engineering Analysis (4 classes)**
These courses are taken by all students entering McCormick. They build a strong background in Linear Algebra, Statics, Systems Analysis, and Differential Equations. These courses also build up a background in MATLAB programming that is useful throughout the undergraduate curriculum and in engineering practice.

<table>
<thead>
<tr>
<th>Class Number</th>
<th>Class Title</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEN ENG 205-1</td>
<td>Engineering Analysis 1</td>
<td>Freshman</td>
</tr>
<tr>
<td>GEN ENG 205-2</td>
<td>Engineering Analysis 2</td>
<td>Freshman</td>
</tr>
<tr>
<td>GEN ENG 205-3</td>
<td>Engineering Analysis 3</td>
<td>Freshman</td>
</tr>
<tr>
<td>GEN ENG 205-4</td>
<td>Engineering Analysis 4</td>
<td>Sophomore</td>
</tr>
</tbody>
</table>

**Honors (by invitation):**

<table>
<thead>
<tr>
<th>Class Number</th>
<th>Class Title</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEN ENG 206-1</td>
<td>Honors Engineering Analysis 1</td>
<td>Freshman</td>
</tr>
<tr>
<td>GEN ENG 206-4</td>
<td>Honors Engineering Analysis 4</td>
<td>Freshman</td>
</tr>
</tbody>
</table>

**Grades:** Students who are unable to complete all of their required math and engineering analysis courses with grades of at least "C-" may not meet the prerequisites for some Chemical Engineering courses.

D. **Design and Communication (3 classes)**
The Design Thinking and Communication (DTC) courses (English and DSGN 106-1,2) introduce incoming engineers to the design process by involving them in a real project for a client. Students learn and follow the design process, culminating in the building of a prototype to satisfy the client’s needs. Informal and formal reports and presentations provide an opportunity to improve technical communication skills, which are of great importance in subsequent engineering courses and in engineering practice. The speech requirement provides additional training in public speaking.
E. **Basic Engineering (5 classes)**

These courses present fundamental engineering topics that are the starting prerequisites for many other courses within the curriculum. Analysis of Chemical Process Systems (210) and Thermodynamics (211) serve as the starting point for the sophomore-level classes in chemical engineering, while Fluid Mechanics (321) begins the junior-level transport sequence.

<table>
<thead>
<tr>
<th>Class Number</th>
<th>Class Title</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM ENG 210</td>
<td>Analysis of Chemical Process Systems</td>
<td>Fr. or So.</td>
</tr>
<tr>
<td>CHEM ENG 211</td>
<td>Thermodynamics</td>
<td>Sophomore</td>
</tr>
<tr>
<td>CHEM ENG 321</td>
<td>Fluid Mechanics</td>
<td>Junior</td>
</tr>
<tr>
<td>MAT SCI 301*</td>
<td>Principles of the Properties of Materials</td>
<td>So., Jr, or Sr.</td>
</tr>
<tr>
<td>CHEM ENG 312</td>
<td>Probability and Statistics for Chemical Engineering</td>
<td>Jr. or Sr.</td>
</tr>
<tr>
<td>IEMS 303**</td>
<td>Statistics</td>
<td>Jr. or Sr.</td>
</tr>
</tbody>
</table>

* - May be replaced by petition with MAT SCI 201 for students transferring from another major that requires MAT SCI 201 for graduation.

** - Requires IEMS 202 Probability as a prerequisite (or another probability equivalent) and EECS 111 is recommended.

F. **Social Sciences & Humanities - Theme (7 classes)**

The humanities/social sciences theme requirement (or “Theme”) calls for McCormick students to develop an area of competency related to the study of social science and humanities. To fulfill the requirement, each student selects a set of related courses built around one central “theme” or topic of interest to the student. There are more than 1,600 courses that qualify.

Choose seven courses total from two categories - **Social & Behavioral Sciences (SBS)** and **Humanities (HUM)**. See the theme guidelines on the McCormick webpage for the updated lists of approved theme courses.

[http://www.mccormick.northwestern.edu/students/undergraduate/social-science-humanities-theme/index.html](http://www.mccormick.northwestern.edu/students/undergraduate/social-science-humanities-theme/index.html)
Nearly all courses from the departments and programs listed in each category will count, but there are a list of disallowed courses from those departments and a list of allowed course from other departments (see webpage). For your theme you must:

- Indicate courses that are thematically related (minimum of three, up to all seven)
- Create a title for their theme and describe it in a brief narrative
- Comply with the following course limits:
  - A maximum of five courses may be chosen from a single category (SBS or HUM)
  - No more than three 100-level courses
  - Exception: up to four 100-level courses if three are foreign language

Visit the McCormick website for a list of departments and courses within the two categories: http://www.mccormick.northwestern.edu/students/undergraduate/social-science-humanities-theme/index.html

G. Unrestricted Electives (5 classes)

These five classes may be taken at any time during an undergraduate's education and may be any class taken from any school. They can be used to pursue minors or certificates in ChE or in other departments, schools, and disciplines.
III. CHEMICAL ENGINEERING MAJOR

A. Required Courses (11 classes)

These classes prepare students for a variety of careers in chemical engineering and form the core of the curriculum.

<table>
<thead>
<tr>
<th>Class Number</th>
<th>Class Title</th>
<th>Year</th>
<th>Prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 210-1*</td>
<td>Organic Chemistry I</td>
<td>Sophomore</td>
<td>CHEM 132/152/172</td>
</tr>
<tr>
<td>CHEM 210-2*</td>
<td>Organic Chemistry II</td>
<td>Sophomore</td>
<td>CHEM 210-1</td>
</tr>
<tr>
<td>CHEM 230-2</td>
<td>Organic Chemistry lab</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHEM ENG 212</td>
<td>Phase Equilibrium and Staged Separations</td>
<td>Sophomore</td>
<td>CHEM ENG 210, 211</td>
</tr>
<tr>
<td>CHEM ENG 275**</td>
<td>Molecular and Cell Biology for Engineers</td>
<td>Soph or Jr.</td>
<td>CHEM 132/152/172, 210, 211, 212, 221</td>
</tr>
<tr>
<td>CHEM ENG 307</td>
<td>Kinetics and Reactor Engineering</td>
<td>Junior</td>
<td>CHEM ENG 210, 211, 212, 321, 322</td>
</tr>
<tr>
<td>CHEM ENG 322</td>
<td>Heat Transfer</td>
<td>Junior</td>
<td>Math Req., GEN ENG 205-4; CHEM ENG 321 is strongly recommended</td>
</tr>
<tr>
<td>CHEM ENG 323</td>
<td>Mass Transfer</td>
<td>Junior</td>
<td>CHEM ENG 321, 322</td>
</tr>
<tr>
<td>CHEM ENG 341</td>
<td>Dynamics and Control of Chemical and Biological Processes</td>
<td>Senior</td>
<td>Senior Standing, CHEM ENG 307, 312, 321, 322</td>
</tr>
<tr>
<td>CHEM ENG 342</td>
<td>Chemical Engineering Laboratory</td>
<td>Senior</td>
<td>CHEM ENG 212, 212, 213, 321, 322, 323</td>
</tr>
<tr>
<td>CHEM ENG 351</td>
<td>Process Economics, Design, &amp; Evaluation</td>
<td>Senior</td>
<td>CHEM ENG 212, 212, 321, 322, 323</td>
</tr>
<tr>
<td>CHEM ENG 352</td>
<td>Chemical Engineering Design Projects</td>
<td>Senior</td>
<td>CHEM ENG 351</td>
</tr>
</tbody>
</table>

* - May be replaced with CHEM 212-1 & CHEM 212-2, CHEM 232-2 (lab)

** - May be replaced with BIOL SCI 201 or 202 (BIOL SCI 215 or 219 course numbering prior to Spring 2021)

Important Notes:

- The grade point average of the 16 courses (11 above + 5 technical electives, see pages 9-10) used to satisfy the Chemical Engineering major requirements must be at least 2.00. Further, no more than two courses may carry a grade of "D".

- None of the 11 required courses above may be taken on a Pass/No Credit (P/N) basis.
B. Technical Electives (5 classes)

The technical electives may be used to create an individualized area of specialization within the major. In this section students will learn of the general requirements for the five technical elective courses as well as some suggested courses for themes within chemical engineering.

**General requirements to be satisfied by all students:**

1. Two 300- or 400-level CHEM ENG classes from *Category A*
2. One 300- or 400-level CHEM ENG class from *Category A* OR CHEM ENG 399 OR approved 200- or 300-level Engineering class from *Category B*
3. CHEM ENG 361 OR BMD ENG 302, 303 OR one approved 200- or 300-level advanced Science/Math class from *Category C*
4. One course from *Category A, B, C, D* OR CHEM ENG 390

**Important notes:**

- **Refer to Appendix B for Approved Classes by Category.** In brief, Category A includes CHEM ENG classes, Category B includes other classes with high engineering content, Category C includes classes with more science content, and Category D includes some classes that don’t neatly fall into one of the other categories.
- Only one unit of CHEM ENG 399 may be counted toward the five technical electives.
- **All 395 classes must be approved by petition (including those suggested below) to count as a technical elective.**
- Only two courses that are counted towards the 5 technical electives may be taken on a Pass/No Credit (P/N) basis. Chemical Engineering courses may not be taken on a P/N basis if they are to be counted toward the 5 technical electives.
- The grade point average of the 16 courses for the major in Chemical Engineering must be at least 2.00. Further, no more than two courses may carry a grade of "P" and no more than two may carry a grade of "D".

Six suggested areas of specialization are described below. Each comprises a list of complementary or related courses that together satisfy the general technical elective requirements (above). Students are not required to follow these suggested lists exactly, but each student’s selected set of electives must still satisfy the general requirements detailed above.

**Areas of Specialization:**

**CHEMICAL PROCESS ENGINEERING**

1. CHEM ENG 345 Process Optimization for Energy and Sustainability
2. CHEM ENG 355 Chemical Product Design
3. CHEM ENG 365 (Sustainability, Technology, and Society), CHEM ENG 367 (Quantitative Methods in Life Cycle Analysis), CHEM ENG 375 (Biochemical Engineering), CHEM ENG 377 (Bioseparations), **OR** MAT SCI 318 (Materials Selection)
4. CHEM ENG 361 Introduction to Polymers
5. Any elective from Category A, B, C, or D

**BIOENGINEERING**

Use BIOL SCI 219 (Cell Biology) in place of CHEM ENG 275 in the major program.

1. CHEM ENG 375 Biochemical Engineering
2. CHEM ENG 372 (Bionanotechnology), CHEM ENG 373 (Biotechnology and Global Health), CHEM ENG 376 (Synthetic Biology), CHEM ENG 377 (Bioseparations), OR CHEM ENG 379 (Computational Biology: Principles and Applications)
3. CHEM ENG OR BMD ENG course from Category A or B
4. BMD ENG 302 (Systems Physiology), BMD ENG 303 (Systems Physiology), BIOL SCI 201 (Molecular Biology) or BIOL SCI 215 (Genetics and Molecular Biology), BIOL SCI 217 (Physiology), BIOL SCI 301 (Biochemistry) OR CHEM 210-3 (Organic Chemistry III)
5. Any elective from Category A, B, C, or D

**ENVIRONMENTAL ENGINEERING AND SUSTAINABILITY**

1. CHEM ENG 365 Sustainability, Technology, and Society
2. CHEM ENG 367 (Quantitative Methods in Life Cycle Analysis) OR CHEM ENG 345 (Process Optimization for Energy and Sustainability)
3. CIV ENG 367 (Chemical Processes in Aquatic Systems) OR MAT SCI 381 (Energy Materials)
4. CHEM ENG 361 (Introduction to Polymers) OR CHEM 393 (Green Chemistry)
5. Any elective from Category A, B, C, or D

**POLYMER SCIENCE AND ENGINEERING**

1. CHEM ENG 361 Introduction to Polymers
2. CHEM ENG 330 Molecular Engineering and Statistical Mechanics
3. MAT SCI 331 Physical Properties of Polymers
4. CHEM 210-3 (Organic Chemistry III), MAT SCI 360 (Electron Microscopy), OR MAT SCI 361 (Crystallography and Diffraction)
5. Any elective from Category A, B, C, or D

**DESIGN**

1. CHEM ENG 355 Chemical Product Design
2. CHEM ENG 345 Process Optimization for Energy and Sustainability
3. DSGN 384-1 (Interdisciplinary Design Projects I), DSGN 308 (Human-Centered Product Design), OR DSGN 384-2 (Interdisciplinary Design Project II)
4. CHEM ENG 361 (Introduction to Polymers) OR CHEM 393 (Green Chemistry)
5. Any elective from Category A, B, C, or D
NANOTECHNOLOGY AND MOLECULAR ENGINEERING
1. CHEM ENG 330 Molecular Engineering and Statistical Mechanics
2. CHEM ENG 361 Introduction to Polymers
3. MAT SCI 376 Nanomaterials
4. CHEM 307 (Materials and Nanochemistry), CHEM 342-2 (Quantum Mechanics and Spectroscopy), OR PHYSICS 358 (Nanolithography)
5. Any elective from Category A, B, C, or D

C. Course Considerations and Course Schedule
The following table contains all of the chemical engineering courses currently offered by the Northwestern Chemical and Biological Engineering Department and the typical times they are offered. This list may be helpful when selecting technical and unrestricted electives.

<table>
<thead>
<tr>
<th>Course</th>
<th>Quarter</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM ENG 210 - Analysis of Chemical Process Systems</td>
<td>Fall, Spring</td>
</tr>
<tr>
<td>CHEM ENG 211 - Thermodynamics</td>
<td>Fall, Winter</td>
</tr>
<tr>
<td>CHEM ENG 212 - Phase Equilibrium and Staged Separations</td>
<td>Winter, Spring</td>
</tr>
<tr>
<td>CHEM ENG 275 - Molecular and Cell Biology for Engineers</td>
<td>Winter</td>
</tr>
<tr>
<td>CHEM ENG 307 - Kinetics and Reactor Engineering</td>
<td>Spring</td>
</tr>
<tr>
<td>CHEM ENG 312 - Probability and Statistics for Chemical Engineering</td>
<td>Winter</td>
</tr>
<tr>
<td>CHEM ENG 321 - Fluid Mechanics</td>
<td>Fall</td>
</tr>
<tr>
<td>CHEM ENG 322 - Heat Transfer</td>
<td>Winter</td>
</tr>
<tr>
<td>CHEM ENG 323 - Mass Transfer</td>
<td>Spring</td>
</tr>
<tr>
<td>CHEM ENG 341 - Dynamics and Control of Chemical and Biological Processes</td>
<td>Winter</td>
</tr>
<tr>
<td>CHEM ENG 342 - Chemical Engineering Laboratory</td>
<td>Fall, Wint, Spr</td>
</tr>
<tr>
<td>CHEM ENG 351 - Process Economics, Design, and Evaluation</td>
<td>Fall, Winter</td>
</tr>
<tr>
<td>CHEM ENG 352 - Chemical Engineering Design Projects</td>
<td>Winter, Spring</td>
</tr>
<tr>
<td>CHEM ENG 330 - Molecular Engineering and Statistical Mechanics</td>
<td>Variable*</td>
</tr>
<tr>
<td>CHEM ENG 345 - Process Optimization for Energy and Sustainability</td>
<td>Winter</td>
</tr>
<tr>
<td>CHEM ENG 355 - Chemical Product Design</td>
<td>Variable*</td>
</tr>
<tr>
<td>CHEM ENG 361 - Introduction to Polymers</td>
<td>Fall</td>
</tr>
<tr>
<td>CHEM ENG 365 - Sustainability, Technology, and Society</td>
<td>Fall</td>
</tr>
<tr>
<td>CHEM ENG 367 – Quantitative Methods in Life Cycle Analysis</td>
<td>Variable*</td>
</tr>
<tr>
<td>CHEM ENG 372 - Bionanotechnology</td>
<td>Winter</td>
</tr>
<tr>
<td>CHEM ENG 373 – Biotechnology and Global Health</td>
<td>Fall</td>
</tr>
<tr>
<td>CHEM ENG 375 - Biochemical Engineering</td>
<td>Winter</td>
</tr>
<tr>
<td>CHEM ENG 376 – Synthetic Biology</td>
<td>Fall*</td>
</tr>
<tr>
<td>CHEM ENG 377 - Bioseparations</td>
<td>Spring*</td>
</tr>
<tr>
<td>CHEM ENG 379 - Computational Biology: Principles and Applications</td>
<td>Spring*</td>
</tr>
<tr>
<td>CHEM ENG 382 – Regulatory Sciences in Biotechnology</td>
<td>Spring*</td>
</tr>
<tr>
<td>CHEM ENG 395 - Selected Topics in Chemical Engineering (by petition)</td>
<td>Variable*</td>
</tr>
<tr>
<td>CHEM ENG 399 - Projects</td>
<td>All year</td>
</tr>
</tbody>
</table>
Not all classes are offered every year. Courses marked with a * in this list may not be offered every year. Students should speak with advisors about predicted future offerings for the purposes of long-term planning. See also the online schedule for the current academic year schedule: http://www.mccormick.northwestern.edu/chemical-biological/courses/index.html

Additional courses to consider when choosing technical electives:

Special topics classes are typically offered year round but have a different area of focus each quarter:

CHEM ENG 395: Special Topics in Chemical Engineering
CHEM ENG 489: Selected Topics in Chemical Engineering

Advanced mathematics courses help build a strong mathematical foundation and are especially useful for students considering graduate school:

ES APPM 311-1,2: Methods of Applied Mathematics*
ES APPM 312: Methods of Applied Mathematics: Complex Variables
MATH 351: Fourier Series and Boundary Value Problems
(MATH 351 and ESAPPM 311-2 are considered duplicate courses; credit cannot be received for both courses).
*ES APPM 311-1,2 to be phased out in 2020 and be replaced by a new course number (TBD)

Students going to graduate school are encouraged to take CHEM ENG 330 Molecular Engineering and Statistical Mechanics and CHEM 342-2 Quantum Mechanics and Spectroscopy.

Computer programming is a useful skill. The following courses may be appropriate depending on your background:

COMP SCI 111 Fundamentals of Computer Programming
COMP SCI 211 Fundamentals of Computer Programming II

Seniors may also take graduate (400-level) Chemical Engineering courses as part of their technical electives. Advance consultation with the advisor and course instructor is required.
IV. ADDITIONAL ACADEMIC OPPORTUNITIES

A. Honors Program
Students with a GPA of 3.50 or higher may apply for admission to the Honors Program during the Junior or Pre-senior year. Admission requires contacting the Associate Dean for Undergraduate Education (Professor Burghardt) in the McCormick School and completing appropriate forms which must be approved by the Honors Program advisor in Chemical Engineering (Prof. Cole) and the Associate Dean.

Requirements:

- GPA of 3.50 or higher
- Two-quarter sequence of independent study (CHEM ENG 399: Projects) with a final report
- Three units of advanced study (must be approved by the Honors Program advisor):
  - One course typically not taken by a large fraction of undergraduate chemical engineers. Examples include ES APPM 311, graduate chemical engineering courses, or a 300-level course in another department with substantial pre-requisites.
  - Two 300- or 400-level technical courses

B. Research Opportunities
Students may receive course credit for research through CHEM ENG 399 Projects. This option is usually limited to juniors and seniors, and it is the student’s responsibility to find a faculty member to serve as supervisor of the project. Many of the faculty in Chemical Engineering also involve undergraduates in their research programs as volunteer researchers, work-study students, or regular-payment research aides. Students should consult their advisors or other faculty concerning such opportunities as well as check with the Work-Study Office. Faculty research interests may be found on the department web page.

www.mccormick.northwestern.edu/chemical-biological/undergraduate/research-opportunities.html
www.mccormick.northwestern.edu/chemical-biological/research/areas
C. Minor in Biotechnology and Biochemical Engineering

This minor provides training for students interested in industries that create and manufacture bio-based fuels and industrial chemicals, biopharmaceuticals, biomaterials, and agents for gene and cell therapies.

Ten units of science and engineering are required for the minor:

1. BIOL SCI 201: Molecular Biology¹
2. BIOL SCI 202: Cell Biology¹
3. BIOL SCI 203: Genetics and Evolution
4. BIOL SCI 301: Biochemistry
5. CHEM ENG 375: Biochemical Engineering
6. CHEM ENG 377: Bioseparations²
7. Biology Laboratories: All of the following (0.34 units each)
   o BIOL SCI 232 Molecular and Cellular Processes Laboratory
   o BIOL SCI 233 Genetics and Molecular Processes Laboratory
   o BIOL SCI 234 Investigative Laboratory
8. One of the following: CHEM ENG 371, 372, 373, 376, 379, 382, 475, 478, 479, or approved 395 by petition
9. A unit of 399³ or an elective from #8 above OR one of the following: BIOL SCI 315, 323, 325, 328, 330, 332, 341, 353, 355, 361, 363, 378, 380, 390, 395, BMD ENG 302, 315, 316, 317, 344, 346, 347, 348, 446, CHEM 210-3, CIV ENG 361-1, 441, 442, MAT SCI 353, 370
10. A unit of 399³ or an elective from #8 above OR one of the following: BIOL SCI 315, 323, 325, 328, 330, 332, 341, 353, 355, 361, 363, 378, 380, 390, 395, BMD ENG 302, 315, 316, 317, 344, 346, 347, 348, 446, CHEM 210-3, CIV ENG 361-1, 441, 442, MAT SCI 353, 370

¹ - CHEM ENG 275 can be used instead of BIOL SCI 201 Molecular Biology or 202 Cell Biology only in cases when a student has taken CHEM ENG 275 before deciding to pursue the minor.
* - BIOL SCI intro sequence courses accepted prior to course renumbering in Spring 2021: BIOL SCI 215 Genetics and Molecular Biology, 217 Physiology, and 219 Cell Biology.
² - CHEM ENG 377 can be taken before 375 and with junior standing; 377 may only be offered in alternate years.
³ - Up to two units of 399 research in an approved lab may be used as electives. Students should verify with the minor coordinator that the project and laboratory are appropriate.

Regulations:
• Students must earn a BA/BS degree from Northwestern University to earn the minor.
• A minimum 2.0 grade point average must be maintained in the 10 courses that define the minor. 
• At least 5 courses of the minor may not be used (double counted) to fulfill requirements in the student’s major program. 
• A maximum of two (2) classes not offered by the department may be taken p/n for the minor. 
• Students must also comply with departmental and McCormick p/n regulations for courses that double count between the minor and the major program.  
• Students not majoring in Chemical Engineering should take the Bio Sci core courses (201, 202, 203 OR 215,217,219 AND 301) listed in the minor before taking Chem Eng 375 and 377. In addition, students should take thermodynamics (Chem 342-1) and recommended Advanced Cell Biology (Bio Sci 315) to prepare for Chem Eng 375 and 377. 
• In order to receive recognition for completing the minor, a student must complete the minor declaration form, obtain the required approvals, and submit the form to the McCormick Academic Services Office before the beginning of the student’s final quarter as an undergraduate.

D. Cooperative Education (Co-op) and Internships
The Cooperative Engineering Education Program (co-op) allows undergraduate engineering students to integrate periods of classroom study with periods of paid, practical work experience related to their academic major and career goals. Permanent employment is not an obligation for either employers or co-op students, but most students receive impressive permanent job offers as a result of the co-op experience. To receive the co-op certificate, students must be in good academic standing and complete a minimum of 4 work quarters of work prior to graduation. To get started, students must attend a co-op orientation session. To get started, register for CRDV 301, and visit the McCormick Office of Career Development for more information. https://www.mccormick.northwestern.edu/career-development/programs/#coop

E. Kellogg Certificate
The Kellogg School of Management Certificate Program for Undergraduates offers early exposure to — and preparation for — careers in consulting, financial services and other data-driven professions. Students enrolled in the program may choose between two four-course certificates: the Financial Economics Certificate or the Managerial Analytics Certificate. Both tracks help students improve their critical thinking skills, business acumen and understanding of strategic models that are used in a wide range of industries and occupations. Additional information and how to apply is available online. http://www.kellogg.northwestern.edu/certificate.aspx

F. Minors and Double Majors
Electives within the Chemical Engineering curriculum may be used to fulfill the departmental program requirements of another major (in McCormick or another school of the University). Satisfactory completion of the requirements for the second program will be noted on the student’s transcript.
McCormick also offers several minors:
www.mccormick.northwestern.edu/academics/undergraduate/programs/certificates-and-minors/

Students interested in pursuing a minor or a double major should consult with their advisor at an early stage.
G.  Pre-med

The Chemical Engineering major can serve as a strong foundation for medical school. Many of the pre-med requirements fit within the major program (Inorganic Chemistry, 2 quarters of Organic Chemistry, Physics, one quarter of Biology, Math) or can be accommodated in the electives (3rd quarter Organic Chemistry, additional Biology, English). The University Academic Advising Center can provide guidance about applying to medical school. www.northwestern.edu/health-professions-advising/pre-med/
V. GENERAL INFORMATION

A. Advising
The McCormick School assigns a First Year Advisor to each incoming freshman. At the end of freshmen year, advisors are reassigned so that the student has an advisor in his or her major. Normally, the advisor continues to advise the same students from sophomore through senior years. Beyond assisting with course selections, the advisor can be helpful in career choices (temporary or permanent employment, graduate studies, etc.) because of the close relationship developed over the years. Students wishing to switch advisors should contact Professor Cole.

Any questions that cannot be handled to the student's satisfaction by his/her assigned advisor should be addressed to Professor Cole (jennifer-cole@northwestern.edu) who is the Director of the Undergraduate Program in the department.

B. Academic Honesty
Students are expected to maintain high standards of integrity in their academic work. Instructions given by faculty regarding the degree of interaction among students allowed on homework, lab reports, projects, etc., must be followed. If you do not understand what is allowed in terms of interaction in a particular course, ask the instructor. In the case of reports that use information from other articles, texts, etc., proper attribution of the references must be made. Plagiarism will not be tolerated. McCormick policies on academic integrity can be found at the following website: https://www.mccormick.northwestern.edu/students/academic-integrity.html

C. Safety
Some of the courses in Chemical Engineering have laboratories to provide meaningful practical experience, and a number of students take CHEM ENG 399 in order to undertake projects in a research laboratory setting. The course instructor, teaching assistants, or research supervisor will instruct you as to safe procedures, and enter you into the safety plan of the lab in which you are working. However, you are cautioned that despite the best instruction, safe practice originates with the student. There is no substitute for common sense. When in doubt about a procedure, ask before you execute it. Make use of safety manuals and material safety data sheets made available to you, and use resources available to you on-line or in the library, such as the Merck Index. Laboratory guidelines can be found at the Office of Research Safety: https://researchsafety.northwestern.edu/

D. Accreditation
The Department of Chemical and Biological Engineering offers the Bachelor of Science Degree in Chemical Engineering. The bachelor of science in chemical engineering program is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org. ABET accreditation, which is administered on a national basis, means among other things that the time spent in undergraduate study at Northwestern helps to meet the requirements for registration as a Professional Engineer.
E. American Institute of Chemical Engineers (AIChE)
Northwestern has an active undergraduate student chapter of the American Institute of Chemical Engineers. This student branch of the main professional society in Chemical Engineering provides a great opportunity to learn more about the department, your fellow students, and career and graduate school opportunities. Events commonly held include informal mixers with faculty and graduate students, short talks by faculty or professionals from companies about work opportunities and interests or the transition from school to work, and informational meetings about finding summer, coop, or permanent employment in the profession or how to choose graduate schools in Chemical Engineering for those planning to pursue M.S. or Ph.D. degrees. Other recent activities include attendance at meetings of the local Chicago AIChE chapter and plant trips. All undergraduates are encouraged to participate. Announcements of meetings will be made in undergraduate classes and will be posted in the Undergraduate Bulletin Board (next to Room E127 TECH) and the AIChE Bulletin Board (next to Room E110 TECH).

F. Employment
Faculty in the department are active in research. Many faculty provide opportunities for undergraduates to participate in exciting new developments in Chemical Engineering and earn modest income. Students interested in such part-time work (academic year) or full-time summer jobs should consult individual faculty and the Work-Study Office for opportunities. The department also hires undergraduates on a limited basis to serve as office help.

For cooperative education opportunities, as well as summer internships with companies, students should consult the McCormick's Engineering Career Development office. http://www.mccormick.northwestern.edu/career-development/

Permanent employment opportunities as well as a limited number of summer positions with companies are regularly handled by University Career Services. Most on-campus interviews are held very early in the fall quarter, with a small number held winter quarter. Undergraduates planning to use the University Career Services Center should see that their resumes and associated material are submitted by early July in order to take full advantage of the fall quarter recruiting season.

G. Graduate School Opportunities
Students who may pursue M.S. or Ph.D. degrees in Chemical Engineering should talk with their advisors and other faculty. Students should be aware that applications usually must be filed by December or early January of the senior year for full consideration for financial aid for graduate studies. Unlike undergraduate school, Ph.D. programs in Chemical Engineering will typically provide full financial aid (monthly stipend plus full tuition payment) to admitted students, regardless of financial background.

Students interested in pursuing graduate degrees in medicine, law, dentistry, business, etc. should consult their advisors and offices at Northwestern specifically set up for this purpose.
## VI. APPENDICES

### A. Appendix A: Sample Course Sequences

**STANDARD 4-YEAR CHEMICAL ENGINEERING PROGRAM**

<table>
<thead>
<tr>
<th>Year:</th>
<th>Fall</th>
<th>Winter</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshman</td>
<td>Math 220-1 (220)*</td>
<td>Math 220-2 (224)*</td>
<td>Math 228-1 (230)*</td>
</tr>
<tr>
<td></td>
<td>Chem 110, 151, or 171</td>
<td>Chem 131, 152, or 172</td>
<td>Chem 132 or ChE 210(^1)</td>
</tr>
<tr>
<td></td>
<td>Gen Eng 205-1</td>
<td>Gen Eng 205-2</td>
<td>Gen Eng 205-3</td>
</tr>
<tr>
<td></td>
<td>Elective or Speech</td>
<td>Dsgn 106-1/Eng 106-1</td>
<td>Dsgn 106-2/Eng 106-2</td>
</tr>
<tr>
<td>Sophomore (variant 1: ChE 210 taken in Freshman year)</td>
<td>Math 228-2 (234)*</td>
<td>ChE 212</td>
<td>Elective or MSE 301</td>
</tr>
<tr>
<td></td>
<td>Gen Eng 205-4</td>
<td>Chem 210-2</td>
<td>Phys 135-3</td>
</tr>
<tr>
<td></td>
<td>Chem 210-1</td>
<td>Phys 135-2</td>
<td>Elective</td>
</tr>
<tr>
<td></td>
<td>ChE 211</td>
<td>Elective</td>
<td>Elective</td>
</tr>
<tr>
<td>Sophomore (variant 2: ChE 210 taken in Sophomore year)</td>
<td>Math 228-2 (234)*</td>
<td>ChE 211</td>
<td>ChE 212</td>
</tr>
<tr>
<td></td>
<td>Chem 210-1</td>
<td>Chem 210-2</td>
<td>Phys 135-3</td>
</tr>
<tr>
<td></td>
<td>Gen Eng 205-4</td>
<td>Phys 135-2</td>
<td>Elective</td>
</tr>
<tr>
<td></td>
<td>ChE 210</td>
<td>Elective</td>
<td>Elective</td>
</tr>
<tr>
<td>Junior</td>
<td>ChE 321</td>
<td>ChE 322</td>
<td>ChE 307</td>
</tr>
<tr>
<td></td>
<td>Elective(^3) or MSE 301</td>
<td>ChE 275(^3)</td>
<td>ChE 323</td>
</tr>
<tr>
<td></td>
<td>Elective</td>
<td>ChE 312(^4)</td>
<td>Elective(^3) or MSE 301</td>
</tr>
<tr>
<td></td>
<td>Elective</td>
<td>Elective</td>
<td>Elective</td>
</tr>
<tr>
<td>Senior (variant 1)</td>
<td>ChE 342</td>
<td>ChE 341</td>
<td>ChE 352</td>
</tr>
<tr>
<td></td>
<td>Elective or MSE 301</td>
<td>ChE 351</td>
<td>Elective</td>
</tr>
<tr>
<td></td>
<td>Elective</td>
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<td>Elective</td>
</tr>
<tr>
<td>Senior (variant 2)</td>
<td>ChE 351</td>
<td>ChE 341</td>
<td>ChE 342</td>
</tr>
<tr>
<td></td>
<td>Elective or MSE 301</td>
<td>ChE 352</td>
<td>Elective</td>
</tr>
<tr>
<td></td>
<td>Elective</td>
<td>Elective</td>
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</tr>
</tbody>
</table>

Notes:

* Math department has updated course numbers starting Fall 2019 (old numbers in parentheses)

1. Students who are ahead in the Math sequence or have completed the Chemistry sequence may be interested in taking the early offering of the ChE sophomore sequence (210, 211, 212). Otherwise students may take an elective.

2. Chemistry 210-3 may be taken here as an advanced science elective; a full year of organic chemistry is required to satisfy standard pre-med requirements.

3. Students pursuing a bio-related specialization, or who wish to satisfy pre-med requirements, typically take Biol Sci 201, 202, 203 during the sophomore or junior year. Biol Sci 201 or 202 can take the place of ChE 275. (Prior to Spring 2021, Biol Sci 215, 217, 219 were the intro courses)

4. IEMS 303 may be used in place of ChE 312, however IEMS 303 has a prerequisite of IEMS 202 and recommended EECS 111. This option may be appealing to students pursuing the Kellogg Certificates.
<table>
<thead>
<tr>
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<tr>
<td></td>
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<td>Elective(^2)</td>
</tr>
<tr>
<td></td>
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<td>ChE 321</td>
<td>ChE 275(^3)</td>
<td>COOP</td>
</tr>
<tr>
<td></td>
<td>Elective(^3) or MSE 301</td>
<td>ChE 322</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Elective</td>
<td>ChE 312(^4)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Elective</td>
<td>Elective</td>
<td></td>
</tr>
<tr>
<td>Pre-Senior</td>
<td>Elective or MSE 301</td>
<td>COOP</td>
<td>ChE 307</td>
</tr>
<tr>
<td></td>
<td>Elective</td>
<td></td>
<td>ChE 323</td>
</tr>
<tr>
<td></td>
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<tr>
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<td>Elective</td>
<td></td>
<td>Elective</td>
</tr>
<tr>
<td>Senior</td>
<td>COOP</td>
<td>ChE 341</td>
<td>ChE 342</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ChE 351</td>
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4. IEMS 303 may be used in place of ChE 312, however IEMS 303 has a prerequisite of IEMS 202 and recommended EECS 111. This option may be appealing to students pursuing the Kellogg Certificates.
5. Students following the traditional coop schedule typically are on coop during the summers after the sophomore, junior, and senior years.
B. Appendix B: Approved Technical Elective Course Listing

Category A

CHEM ENG 330 Molecular Engineering and Statistical Mechanics
CHEM ENG 345 Process Optimization for Energy and Sustainability
CHEM ENG 355 Chemical Product Design
CHEM ENG 361 Introduction to Polymers
CHEM ENG 364 Chemical Processing and the Environment
CHEM ENG 365 Sustainability, Technology, and Society
CHEM ENG 367 Quantitative Methods in Life Cycle Analysis

CHEM ENG 372 Bionanotechnology
CHEM ENG 373 Biotechnology and Global Health
CHEM ENG 375 Computational Biology: Principles and Applications
CHEM ENG 377 Bioseparations
CHEM ENG 379 Special Topics in Chemical Engineering (by petition)

All 400-level CHEM ENG classes

Category B (listings by department or educational program)

Biomedical Engineering

271-0: Intro to Biomechanics
301-0: Systems Physiology
302-0: Systems Physiology
303-0: Systems Physiology
314-0: Models in Biochemistry
315-0: Appl of Genetic Engineering
316-0: Engg Design of Therap. Antibodies
317-0: Biochemical Sensors
325-0: Intro to Medical Imaging
327-0: Magnetic Resonance Imaging
333-0: Modern Optical Microscopy & Imaging
343-0: Biomaterials & Medical Devices
344-0: Biological Performance of Materials
346-0: Tissue Engineering
347-0: Foundations of Regenerative Engg
348-0: Applications of Regenerative Engg
365-0: Control of Limbs and Artificial Replcmnt
366-0: Biomechanics of Movement
371-0: Mechanics of Biological Tissue
377-0: Intermediate Fluid Mechanics
378-0: Transport Fundamentals
390-1: Biomedical Engineering Design
395-0: Topics in Biomed Engg (by petition)

Civil and Environmental Engineering

205-0: Economics and Finance for Engineers
216-0: Mechanics Of Materials I
221-0: Theory of Structures I
250-0: Earth Surface Engineering
302-0: Engineering Law
327-0: Finite Element Methods in Mechanics
340-0: Hydraulics and Hydrology
346-0: Ecohydrology
355-0: Engineering Groundwater Flow
361-1: Environmental Microbiology
361-2: Public & Environmental Health
363-0: Environmental Engg App I: Air & Land
364-0: Sustainable Water Systems
367-0: Chemical Processes in Aquatic Systems
368-0: Sustainability: The City
371-0: Transportation Planning/Analysis
376-0: Transportation System Operations
395-0: Special Topics (by petition)

General Engineering

220-1,2: Analy/Comp Graph (0.5 unit each course, need to take both for 1 credit equivalent)
### Computer Engineering (COMP_ENG)

- 205-0: Fund of Computer System Software
- 346-0: Microprocessor System Design
- 357-0: Design Automation in VLSI
- 358-0: Intro to Parallel Computing
- 361-0: Comp Architecture I
- 366-0: Embedded Systems
- 391-0: CMOS VLSI Circuit Design
- 392-0: VLSI Systems Design Projects
- 393-0: Adv Low Power VLSI & Mix-Signal IC
- 394-0: Software Project Mgt Develop
- 395-0: Special Topics (by petition)

### Computer Science (COMP_SCI)

- 211-0: Fundamentals of Computer Prog II
- 213-0: Introduction to Computer Systems
- 214-0: Data Structures & Algorithms
- 230-0: Programming for Engineers
- 321-0: Programming Languages
- 322-0: Compiler Construction
- 325-1: Artificial Intelligence Programming
- 337-0: Natural Language Processing
- 338-0: Practicum Intelligent Info Systems
- 339-0: Intro to Database Systems
- 340-0: Introduction to Networking
- 343-0: Operating Systems
- 344-0: Design of Computer Problem Solvers
- 345-0: Distributed Systems
- 348-0: Intro Artificial Intelligence
- 349-0: Machine Learning
- 351-1: Intro to Computer Graphics
- 393-0: Software Construction
- 394-0: Agile Software Develop
- 396-0: Special Topics (by petition)

### Design Engineering

- 250-0: Physical Electronics and Devices
- 307-0: Communications Systems
- 308-0: Adv Electromagnetics & Photonics
- 332-0: Intro to Computer Vision
- 333-0: Intro Communication Networks
- 353-0: Digital Microelectronics
- 359-0: Digital Signal Processing
- 360-0: Intro to Feedback Systems
- 363-0: Digital Filtering
- 374-0: Intro to Digital Control
- 378-0: Digital Communications
- 379-0: Lasers and Coherent Optics
- 380-0: Wireless Communications
- 382-0: Photonic Info Processing
- 383-0: Fiber Optic Communications
- 390-0: Intro to Robotics
- 395-0: Special Topics (by petition)

### Industrial Engineering and Management Sciences

- 304-0: Stat Learning for Data Analysis
- 307-0: Quality Improvement by Expt Design
- 308-0: Data Science & Analytics
- 310-0: Operations Research
- 313-0: Foundations of Optimization
- 315-0: Stochastic Models
- 317-0: Discrete Event Systems Simulation
- 351-0: Optimization Methods in Data Science
- 373-0: Intro to Financial Engineering
- 381-0: Supply Chain Modeling & Analysis
- 382-0: Production Planning & Scheduling
- 383-0: Service Operations Management
- 395-0: Special Topics (by petition)

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### Electrical Engineering (ELEC_ENG)

- 202-0: Intro to Electrical Engineering
- 225-0: Fundamentals of Electronics

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### Notes

- Design Engineering
- Industrial Engineering and Management Sciences
- Electrical Engineering (ELEC_ENG)
Materials Science and Engineering
314-0: Thermodynamics of Materials
315-0: Phase Equilibria & Diffusion of Mats
316-1: Microstructural Dynamics
316-2: Microstructural Dynamics
318-0: Materials Selection
332-0: Mechanical Behavior of Solids
333-0: Composite Materials
341-0: Intro Modern Ceramics
351-2: Intro Physics of Materials
355-0: Electronic Materials
360-0: Electron Microscopy
362-0: Imperfections
370-0: Biomaterials
376-0: Nanomaterials
380-0: Intro Surface Sci & Spectroscopy
381-0: Energy Materials
382-0: Electrochem Energy Mats & Devices
385-0: Electronic/Thermal Properties Mats
390-0: Materials Design
391-0: Process Design
395-0: Special Topics (by petition)

Mechanical Engineering
224-0: Experimental Engineering
233-0: Electronics Design
240-0: Mechanical Design & Manufacturing
314-0: Machines Dynamics
315-0: Theory of Machines: Design Elements
333-0: Intro to Mechatronics
340-1: Computer Integ Manuf (each course [1,2,3] is 1 unit)
340-2: Computer Integrated Manufacturing
340-3: Computer Integrated Manufacturing
346-0: Intro to Tribology
359-0: Reliability Engineering
362-0: Stress Analysis
363-0: Mechanical Vibrations
373-0: Engg Fluid Mechanics
381-0: Heat Transfer
381-0: Intro to MEMS
382-0: Expts in Micro/Nano Sci and Engg
385-0: Nanotechnology
390-0: Intro Dynamic Systems
395-0: Special Topics (by petition)

Category C (listings by department or educational program)

Biological Sciences (in Weinberg)
201-0: Molecular Biology
202-0: Cell Biology
203-0: Genetics and Evolution
215-0: Genetics and Molecular Biology*
217-0: Physiology*
219-0: Cell Biology*

*not offered after Winter 2021

301-0: Biochemistry
315-0: Advanced Cell Biology
319-0: Biology of Animal Viruses
323-0: Bioinformatics
328-0: Microbiology
333-0: Plant-Animal Interactactions

Chemistry (in Weinberg)
210-3: Organic Chemistry
220-0: Intro Instrumental Analysis
301-0: Principles Organic Chemistry
302-0: Principles Inorganic Chemistry
303-0: Principles Physical Chemistry
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>305-0</td>
<td>Chemistry Life Processes</td>
</tr>
<tr>
<td>306-0</td>
<td>Environmental Chemistry</td>
</tr>
<tr>
<td>307-0</td>
<td>Materials and Nanochemistry</td>
</tr>
<tr>
<td>314-0</td>
<td>Bioorganic Chemistry</td>
</tr>
<tr>
<td>316-0</td>
<td>Medicinal Chemistry</td>
</tr>
<tr>
<td>329-0</td>
<td>Analytical Chemistry</td>
</tr>
<tr>
<td>333-0</td>
<td>Inorganic Chemistry</td>
</tr>
<tr>
<td>342-1</td>
<td>Thermodynamics</td>
</tr>
<tr>
<td>342-2</td>
<td>Quantum Mech and Spectroscopy</td>
</tr>
<tr>
<td>342-3</td>
<td>Kinetics and Stat Thermodynamics</td>
</tr>
<tr>
<td>350-1</td>
<td>Adv Laboratory 1</td>
</tr>
<tr>
<td>350-2</td>
<td>Adv Laboratory 2</td>
</tr>
<tr>
<td>350-3</td>
<td>Adv Laboratory 3</td>
</tr>
<tr>
<td>393-0</td>
<td>Green Chemistry</td>
</tr>
<tr>
<td>202-0</td>
<td>The Health of the Biosphere</td>
</tr>
<tr>
<td>202-0</td>
<td>Mathematics (in Weinberg)</td>
</tr>
<tr>
<td>307-0</td>
<td>Probability and Stochastic Processes</td>
</tr>
<tr>
<td>310-0</td>
<td>Probability and Stochastic Processes</td>
</tr>
<tr>
<td>310-0</td>
<td>Probability and Stochastic Processes</td>
</tr>
<tr>
<td>314-0</td>
<td>Prob and Statistics for Econometrics</td>
</tr>
<tr>
<td>325-0</td>
<td>Complex Analysis</td>
</tr>
<tr>
<td>351-0</td>
<td>Fourier Analysis</td>
</tr>
<tr>
<td>353-0</td>
<td>Qualitative Differential Eqs</td>
</tr>
<tr>
<td>354-1</td>
<td>Chaotic Dynamical Systems</td>
</tr>
<tr>
<td>354-2</td>
<td>Chaotic Dynamical Systems</td>
</tr>
<tr>
<td>360-1</td>
<td>MENU: Applied Analysis</td>
</tr>
<tr>
<td>360-2</td>
<td>MENU: Applied Analysis</td>
</tr>
<tr>
<td>366-1</td>
<td>Math Models in Finance</td>
</tr>
<tr>
<td>366-2</td>
<td>Math Models in Finance</td>
</tr>
<tr>
<td>368-0</td>
<td>Intro Optimization</td>
</tr>
<tr>
<td>202-0</td>
<td>Biol. &amp; Ecological Principles</td>
</tr>
<tr>
<td>203-0</td>
<td>Earth in the Anthropocene</td>
</tr>
<tr>
<td>317-0</td>
<td>Biogeochemistry</td>
</tr>
<tr>
<td>330-0</td>
<td>Classical Mechanics</td>
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<tr>
<td>330-0</td>
<td>Classical Mechanics</td>
</tr>
<tr>
<td>332-0</td>
<td>Statistical Mechanics</td>
</tr>
<tr>
<td>333-1</td>
<td>Adv Electricity and Magnetism</td>
</tr>
<tr>
<td>333-2</td>
<td>Adv Electricity and Magnetism</td>
</tr>
<tr>
<td>337-0</td>
<td>Intro Solid-State Phys</td>
</tr>
<tr>
<td>357-0</td>
<td>Biophotonics Lab</td>
</tr>
<tr>
<td>358-0</td>
<td>Nanolithography</td>
</tr>
<tr>
<td>361-0</td>
<td>Crystallography &amp; Diffraction</td>
</tr>
<tr>
<td>330-0</td>
<td>Physics (in Weinberg)</td>
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<tr>
<td>330-0</td>
<td>Classical Mechanics</td>
</tr>
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<tr>
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</tr>
<tr>
<td>357-0</td>
<td>Biophotonics Lab</td>
</tr>
<tr>
<td>358-0</td>
<td>Nanolithography</td>
</tr>
</tbody>
</table>

**Category D (listings by engineering department or educational program)**

**Civil and Environmental Engineering**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>304-0</td>
<td>Civil/Envr Eng Syst Analysis</td>
</tr>
<tr>
<td>306-0</td>
<td>Uncert Analysis Civ Eng</td>
</tr>
<tr>
<td>203-0</td>
<td>Intro to Computer Eng</td>
</tr>
<tr>
<td>303-0</td>
<td>Adv Digital Logic Design</td>
</tr>
</tbody>
</table>

**Computer Engineering (COMP_ENG)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>330-0</td>
<td>Human Computer Interaction</td>
</tr>
<tr>
<td>336-0</td>
<td>Design Analysis Algorithms</td>
</tr>
<tr>
<td>370-0</td>
<td>Computer Game Design</td>
</tr>
</tbody>
</table>

**Computer Science (COMP_SCI)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>221-0</td>
<td>Fundamentals of Circuits</td>
</tr>
<tr>
<td>222-0</td>
<td>Fundamentals Signals &amp; Systems</td>
</tr>
</tbody>
</table>

**Electrical Engineering (ELECT_ENG)**
223-0: Fund of Solid State Engineering
224-0: Fund of Electromag & Photonics
302-0: Prob Systms Random Signals
328-0: Numerical Methods for Eng
381-0: Electronic Properties Materials
384-0: Solid State Electronic Devices
385-0: Optoelectronics
388-0: Nanotechnology
389-0: Superconductivity Applications

**Design Engineering**
(may combine 2 half unit courses)
240-0: Solid Modeling (0.5 unit)
245-0: Intro 3D CAD: NX I Lect (0.5 unit)
246-0: Intro 3D CAD: NX II Lect (0.5 unit)
306-0: UX Design
320-0: Intro Industrial Design Methods
345-0: Computer-Aid Manufact (0.5 unit)
348-0: Adv Topics: Rapid Prototyp (0.5 unit)
350-0: Intellectual Property and Innovation
380-1: Industrial Design Projects I
380-2: Industrial Design Projects II

**Industrial Engineering and Management Sciences**
202-0: Probability
325-0: Engineering Entrepreneurship
341-0: Social Network Analysis
342-0: Organizational Behavior
343-0: Project Management for Engineers
345-0: Negotiation and Conflict Resolution
365-0: Analytics for Social Good

**Materials Science and Engineering**
337-0: Conducting Polymers
351-1: Intro Physics Materials
371-0: Biominerals: Heir Archt/Funct