Northwestern | McCORMICK SCHOOL OF ENGINEERING

DEPARTMENT OF CHEMICAL AND BIOLOGICAL ENGINEERING

INFORMATION FOR MAJORS IN CHEMICAL ENGINEERING

Fall 2024

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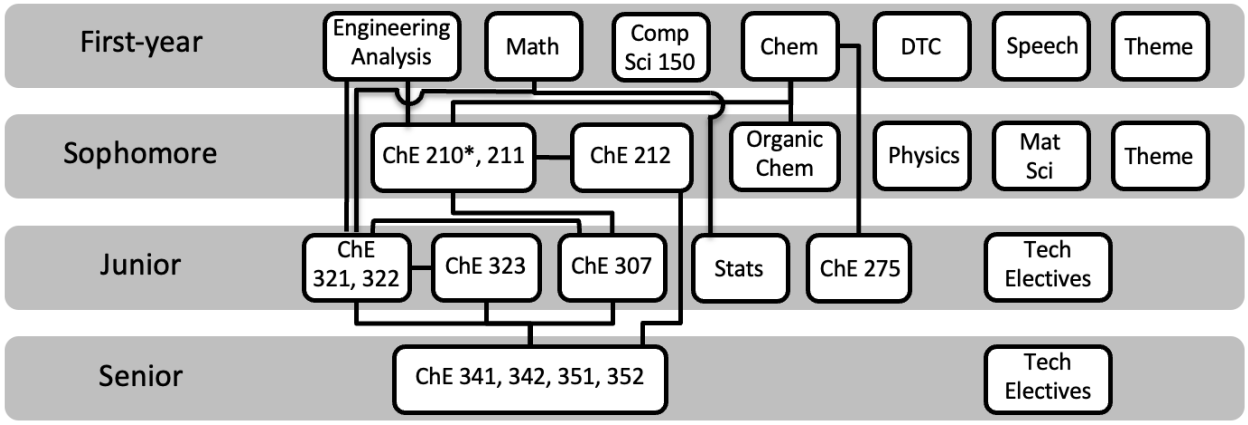
Northwestern | McCORMICK SCHOOL OF ENGINEERING

Quick Reference Guide

Chemical Engineering Curriculum - Prerequisite Flowchart



**ChE 210 may be taken in the first year or sophomore year.*

Total Requirements - 48 classes

Basic Courses:

A. Mathematics - 4 classes
- ❑ ❑ MATH 220-1,2 and
- ❑ ❑ MATH 228-1,2

B. Basic Sciences - 4 classes
- ❑ ❑ CHEM 131,132, or 151,152, or 171,172
- ❑ CHEM ENG 275 ❑ PHYSICS 135-2

**Chemistry and Physics have associated labs*

C. Engineering Analysis - 4 classes
- ❑ ❑ ❑ ❑ GEN ENG 205-1,2,3,4

D. Design and Communication - 3 classes
- ❑ ❑ ENGLISH & DSGN 106-1,2
- ❑ COMM ST (Speech) 102, or PERF ST (Performance) 103 or 203

Distribution Requirements:

E. ❑ Social Sci/Humanities (Theme) - 7 classes

F. ❑ Unrestricted Electives - 5 classes

Core Curriculum:

G. Major Program – 16 required classes + 5 technical electives
- ❑ ❑ CHEM 215-1,2: Organic Chemistry
- ❑ CHEM ENG 210: Analysis of Chemical Process Systems
- ❑ CHEM ENG 211: Thermodynamics
- ❑ CHEM ENG 212: Phase Equilibrium and Staged Separations
- ❑ CHEM ENG 307: Kinetics & Reactor Engineering
- ❑ CHEM ENG 312: Probability and Statistics for Chemical Engineers OR IEMS 303
- ❑ CHEM ENG 321: Fluid Mechanics
- ❑ 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
- ❑ COMP SCI 150: Fundamentals of Computer Programming 1.5
- ❑ MAT SCI 301: Chemical Aspects of Engineering Materials (has lab)

❑ 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, Nanotechnology and Molecular Engineering, or Polymer Science and Engineering

Table of Contents

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 you 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, you 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.

The following statements are our department's Program Educational Objectives, or what we are training you to become and do as professionals. 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 global populations.

2. Think critically and creatively, especially about the use of technology to achieve equitable and sustainable solutions to local and global problems.

3. Be stewards for a positive impact 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 graduate programs and professional schools.

This document lists the degree requirements for chemical engineering undergraduates in the McCormick BS Program. You may plan your 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 ANALYSIS, AND THEME COURSES

A. Mathematics (4 classes)

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

Class Number	Class Title	Year
MATH 220-1	Single-Variable Differential Calculus	First-year
MATH 220-2	Single-Variable Integral Calculus	First-year
MATH 228-1	Multivariable Differential Calculus for Engineering	First-year
MATH 228-2	Multivariable Integral Calculus for Engineering	Sophomore

Honors (by invitation):

Class Number	Class Title	Year
ESAM 252-1	Honors Calculus for Engineers (Substitutes MATH 228-1)	First-year
ESAM 252-2	Honors Calculus for Engineers (Substitutes MATH 228-2)	First-year

B. 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.

Class Number	Class Title	Year
GEN ENG 205-1	Engineering Analysis 1	First-year
GEN ENG 205-2	Engineering Analysis 2	First-year
GEN ENG 205-3	Engineering Analysis 3	First-year
GEN ENG 205-4	Engineering Analysis 4	Sophomore

Honors (by invitation):

Class Number	Class Title	Year
GEN ENG 206-1	Honors Engineering Analysis 1	First-year
GEN ENG 206-4	Honors Engineering Analysis 4	First-year

A note on grades: If you are unable to complete all your required math and engineering analysis courses with grades of at least "C-" you may not meet the prerequisites for some Chemical Engineering courses. Please speak with your advisor or the Undergrad Program Director in Chemical Engineering if you are in this situation.

If you are transferring into the major, you may have component courses in place of the Engineering Analysis sequence. Component courses typically include Math 240, Math 250, Physics 135-1, Comp Sci 110 or 111, and EA2. You should consult with your advisor or Undergrad Program Director for assistance with planning courses.

C. Basic Sciences (4 classes)

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

Class Number	Class Title	Year
CHEM 131 & 132*	General Chemistry 1 & 2	First-year
OR CHEM 151 & 152	Accelerated General Chemistry 1 &2	First-year
OR CHEM 171 &	Advanced General Inorganic Chemistry	First-year
CHEM 172	Advanced General Physical Chemistry	First-year
AND		
CHEM ENG 275**	Molecular & Cell Biology for Engineers	Soph or Jr
AND		
PHYSICS 135-2	General Physics – Electricity; Magnetism	Sophomore
OR PHYSICS 140-2	Fundamentals of Physics – Electricity; Magnetism	Sophomore

* Note 1: CHEM 110 is taken as an unrestricted elective for students completing the Chem 131, 132 sequence.

** Note 2: May be replaced with BIOL SCI 201 or 202. If you have tested out of 201, and have completed BIOL SCI 202, you may use 202 to replace CHEM ENG 275.

*** Note 3: Chemistry and Physics require concurrent enrollment in the laboratory courses.

**** Note 4: IMPORTANT: If you enroll in one of the general chemistry courses **you must** complete of the **full sequence** (131 and 132; or 151 and 152; or 171 and 172) **with grades of C- or above**, or you will be unable to register for Chem 215-1. This applies **regardless** of whether you have AP credits for General Chemistry.

A note on grades: The prerequisites for Organic Chemistry are the completion of the general chemistry sequence with laboratory with all grades of " C- " or above.

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. You will 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.

Class Number	Class Title	Year
ENGLISH 106-1,2	Writing in Special Contexts	First-year
DSGN 106-1,2	Design Thinking and Communication	First-year

The speech requirement provides additional training in public speaking. Select ONE of the following course options:

Class Number	Class Title	Year
COMM ST 102	Public Speaking	Any
PERF ST 103	Analysis and Performance of Literature	Any
PERF ST 203	Performance Culture and Communication	Any

E. Social Sciences & Humanities - Theme (7 classes)

The humanities/social sciences theme requirement (or "Theme") invites you to develop an area of competency related to the study of social science and humanities. To fulfill the requirement, you will select 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. 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 is a list of disallowed courses from those departments and a list of allowed courses 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 your 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*

Theme forms are part of the McCormick Advising System (MAS). Please log in to complete your theme form within MAS, ideally before your junior year, even if you don't know whether a class will be offered in the quarter you want to take it. There is no limit to the number of times you can edit your theme form. And it is better to get approval for a theme before you commit to taking a class that won't be approved for the theme.

F. Unrestricted Electives (5 classes)

These five classes may be taken at any time during your undergraduate education and may be any class taken from any school. These courses can be used to pursue minors or certificates in ChE or in other departments, schools, and disciplines.

III. CHEMICAL ENGINEERING MAJOR

A. Required Core Courses (16 classes)

These classes prepare you for a variety of careers in chemical engineering and form the core of the curriculum. The fundamentals presented in these courses are useful in many fields from biological engineering to materials and energy engineering to consumer and chemical products, to name just a few.

In the sophomore year you begin with Analysis of Chemical Process Systems (210) and Thermodynamics (211) which serve as the starting point for understanding chemical and molecular behavior and interactions. While Fluid Mechanics (321) begins the junior-level transport sequence that discusses the movement of chemical entities mass, momentum, and energy. Upper-level courses explore further topics, such as the transformation and separation of chemicals. Capstone experiences in the senior year put all these concepts together into a system-wide analysis of chemical processes and equipment.

100- and 200-level courses

Class Number	Class Title	Year	Prerequisites
CHEM 215-1*	Organic Chemistry I	Sophomore	CHEM 132/152/172
CHEM 215-2*	Organic Chemistry II	Sophomore	CHEM 215-1
CHEM ENG 101**	Getting to Know Chemical Engineering	First-year or Sophomore	
CHEM ENG 210	Analysis of Chemical Process Systems	First-year or Sophomore	CHEM 132/152/172
CHEM ENG 211	Thermodynamics	Sophomore	CHEM ENG 210
CHEM ENG 212	Phase Equilibrium and Staged Separations	Sophomore	CHEM ENG 210, 211
COMP SCI 150	Fundamentals of Computer Programming 1.5	First-year or Sophomore	COMP SCI 110/111, or GEN ENG 205-1

* All Organic Chemistry courses **require** concurrent registration in the lab (CHEM 235-1,2). Sequence may be replaced with CHEM 217-1,2 (lab 237-1,2) for ISP students.

** CHEM ENG 101 is an optional, 0-unit course designed to introduce the major and careers in chemical engineering as well as introducing you to your fellow chemical engineering students. It is intended for first- and second-year students who are considering chemical engineering as a major.

300-level courses

Class Number	Class Title	Year	Prerequisites
CHEM ENG 307	Kinetics and Reactor Engineering	Junior	CHEM ENG 210, 211, 321, 322
CHEM ENG 312 **OR** IEMS 303*	Probability and Statistics for Chemical Engineering	Jr. or Sr.	Completion of math requirements
CHEM ENG 321	Fluid Mechanics	Junior	Completion of math and GEN ENG 205-4 (C- or better)
CHEM ENG 322	Heat Transfer	Junior	Math Req., GEN ENG 205-4; CHEM ENG 321 is strongly recommended
CHEM ENG 323	Mass Transfer	Junior	CHEM ENG 321, 322
CHEM ENG 341	Dynamics and Control of Chemical and Biological Processes	Senior	Senior Standing, CHEM ENG 307
CHEM ENG 342	Chemical Engineering Laboratory	Senior	CHEM ENG 212, 307, 321, 322, 323
CHEM ENG 351	Process Economics, Design, & Evaluation	Senior	CHEM ENG 212, 307, 321, 322, 323
CHEM ENG 352	Chemical Engineering Design Projects	Senior	CHEM ENG 351
MAT SCI 301**	Chemical Aspects of Engineering Materials	So., Jr., or Sr.	CHEM 131/151/171

* Requires IEMS 302 Probability as a prerequisite (or another probability equivalent) and COMP SCI 111 is recommended.

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

A note on grades:

- The grade point average of the 21 courses (16 above + 5 technical electives, see page 10) used to satisfy the Chemical Engineering major requirements must be at least 2.00. Further, no more than three courses may carry a grade of "D".
- None of the 16 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 you 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 (or 399 in general) may be counted toward the five technical electives. Additional units will be placed in unrestricted 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 21 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 three may carry a grade of "D".

Six suggested areas of specialization are described in this section. Each comprises a list of complementary or related courses that together satisfy the general technical elective requirements (above). You are not required to follow these suggested lists exactly, but your 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

Can use BIOL SCI 201 or 202 (Molecular Biology or Cell Biology) in place of CHEM ENG 275.

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), CHEM ENG 378 (Deconstructing Synthetic Biology), **OR** CHEM ENG 379 (Computational Biology: Analysis and Design of Living Systems)
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 202 (Cell Biology), BIOL SCI 301 (Biochemistry), **OR** CHEM 215-3 (Advanced Organic Chemistry)
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 **OR** CHEM ENG 395 Special Topic “Structure and Dynamics of Soft Materials”
3. MAT SCI 331 Soft Materials
4. CHEM 215-3 (Advanced Organic Chemistry), 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.

Course	Quarter
CHEM ENG 210 - Analysis of Chemical Process Systems	Fall, Spring
CHEM ENG 211 - Thermodynamics	Winter
CHEM ENG 212 - Phase Equilibrium and Staged Separations	Spring
CHEM ENG 275 - Molecular and Cell Biology for Engineers	Winter
CHEM ENG 307 - Kinetics and Reactor Engineering	Spring
CHEM ENG 312 - Probability and Statistics for Chemical Engineering	Winter
CHEM ENG 321 - Fluid Mechanics	Fall
CHEM ENG 322 - Heat Transfer	Winter
CHEM ENG 323 - Mass Transfer	Spring
CHEM ENG 341 - Dynamics and Control of Chemical and Biological Processes	Winter
CHEM ENG 342 - Chemical Engineering Laboratory	Fall, Wint, Spr
CHEM ENG 351 - Process Economics, Design, and Evaluation	Fall, Winter
CHEM ENG 352 - Chemical Engineering Design Projects	Winter, Spring
CHEM ENG 330 - Molecular Engineering and Statistical Mechanics	Variable^{+}
CHEM ENG 345 - Process Optimization for Energy and Sustainability	Winter
CHEM ENG 355 - Chemical Product Design	Variable^{+}
CHEM ENG 361 - Introduction to Polymers	Fall
CHEM ENG 365 - Sustainability, Technology, and Society	Fall
CHEM ENG 367 - Quantitative Methods in Life Cycle Analysis	Variable^{+}
CHEM ENG 372 - Bionanotechnology	Winter
CHEM ENG 373 - Biotechnology and Global Health	Fall
CHEM ENG 375 - Biochemical Engineering	Winter
CHEM ENG 376 - Synthetic Biology	Fall^{+}
CHEM ENG 377 - Bioseparations	Spring
CHEM ENG 378 – Deconstructing Synthetic Biology	Winter^{+}
CHEM ENG 379 - Computational Biology: Analysis and Design of Living Systems	Spring^{+}
CHEM ENG 382 - Regulatory Sciences in Biotechnology	Spring^{+}
CHEM ENG 395 - Selected Topics in Chemical Engineering (by petition)	Variable^{+}
CHEM ENG 399 - Projects	All year

Not all classes are offered every year. Courses marked with a + in this list may be offered infrequently. You should speak with advisors about predicted future offerings for the purposes of long-term planning. See the online schedule for the current academic year: 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

*CHEM ENG 395 courses must be approved by petition for use as technical electives, as by their nature they may span engineering topics, advanced math and science, as well as general education, and therefore how they can be counted within the five technical electives will vary from offering to offering.

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

ES APPM 311:	Methods of Applied Mathematics
ES APPM 312:	Complex Variables
MATH 351:	Fourier Series and Boundary Value Problems

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 I (Can be taken before COMP SCI 150 Fundamentals of Computer Programming 1.5)
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

If you have a GPA of 3.50 or higher, you may apply for admission to the Honors Program during the Junior or Pre-senior year. Admission requires contacting the Office for Undergraduate Engineering in the McCormick School and completing appropriate forms which must be approved by the Research advisor (the faculty member leading the lab), the Honors Program advisor in Chemical Engineering (Professor Cole), and the Associate Dean (Professor Burghardt).
www.mccormick.northwestern.edu/academics/undergraduate/programs/honors-and-combined-degrees/undergraduate-honors.html

It is a good idea to check in with the Honors Program advisor to discuss the coursework requirements prior to submitting the form.

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 prerequisites.
    - Two 300- or 400-level technical courses
    - Often these courses can count as your BS technical electives

B. Research Opportunities

You may receive course credit for research through CHEM ENG 399 Projects. This option is open to any student but is most popular amongst 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. You should consult your 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.

These two pages are specific to chemical engineering research:

- www.mccormick.northwestern.edu/chemical-biological/research/areas

- www.mccormick.northwestern.edu/chemical-biological/academics/undergraduate/research-opportunities.html

The McCormick Research Opportunities page also includes useful information, including suggestions for finding a lab as well as the McCormick Summer Research Grant opportunities. www.mccormick.northwestern.edu/students/undergraduate/research-opportunities/

Also check out the **Office of Undergraduate Research (OUR)** for more information on connecting to opportunities and getting funding (summer or academic year grants) for research projects. undergradresearch.northwestern.edu/

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, or for students interested in graduate study in biotechnology research. This minor will appear on transcripts.

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

1. BIOL SCI 201: Molecular Biology[1,2]
2. BIOL SCI 202: Cell Biology[1]
3. BIOL SCI 203: Genetics and Evolution
4. BIOL SCI 301: Biochemistry
5. CHEM ENG 375: Biochemical Engineering
6. CHEM ENG 377: Bioseparations[3]
7. Biology Laboratories[4]: 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

    Or a unit of 399 in an approved laboratory.
8. One of the following: CHEM ENG 372, 373, 376, 378, 379, 382, 470, 478, or approved 395 by petition
9. A unit of 399[5] or an elective from #8 above **OR** one of the following: BIOL SCI 315, 323, 325, 328, 332, 341, 354, 355, 360, 361, 363, 378, 380, 390, 395, BMD ENG 311, 317, 344, 346, 347, 348, 443, 445, 446, CHEM 215-3, CIV ENV 361-1, 442, 447, MAT SCI 353, 371
10. A unit of 399[5] or an elective from #8 above **OR** one of the following: BIOL SCI 315, 323, 325, 328, 332, 341, 354, 355, 360, 361, 363, 378, 380, 390, 395, BMD ENG 311, 317, 344, 346, 347, 348, 443, 445, 446, CHEM 215-3, CIV ENV 361-1, 442, 447, MAT SCI 353, 371

Footnotes:

[1] CHEM ENG 275 can be used instead of BIOL SCI 201 or 202 only in cases when a student has taken CHEM ENG 275 before deciding to pursue the minor.

[2] The Biotech Minor requires 3 units of Biology coursework. Exemptions or course reductions are NOT granted for students taking the Biological Sciences Department placement test, and who test out of and skip BIOL SCI 201. These students may complete BIOL SCI 202 and 203 and petition to use an upper-level Biology course to complete the required 3 units.

[3] CHEM ENG 377 can be taken before 375 and with junior standing; 377 may only be offered in alternate years.

[4] The full set of these courses may be used to complete the laboratory component of the minor.

[5] 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:

- You 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 units that define the minor.
- At least 5 units of the minor may not be used (double counted) to fulfill requirements in your major program.
- A maximum of two (2) classes not offered by the department may be taken P/N for the minor. You must also comply with departmental and McCormick P/N regulations for courses that double count between the minor and the major program.
- If you are outside of the Chemical Engineering major, you should take the Bio Sci core courses (201, 202, 203, AND 301) listed in the minor before taking Chem Eng 375 and 377. In addition, you 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, you must complete the minor declaration form, obtain the required approvals, and submit the form to the McCormick Academic Services Office before the beginning of your final quarter as an undergraduate. McCormick students may find this form in MAS (McCormick Advising System).

D. Cooperative Education (Co-op) and Internships

The Cooperative Engineering Education Program (co-op) allows you to integrate periods of classroom study with periods of paid, practical work experience related to your 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, you must be in good academic standing and complete a minimum of 4 work quarters of work prior to graduation. To get started, you must attend a co-op orientation session. Register for CRDV 301, and visit the Engineering Career Development (ECD) Office for more information. When you are

completing a co-op term you will register for CRDV 310. www.mccormick.northwestern.edu/career-development/programs/#coop

Internships are another type of work-experience opportunity that ChBE students take advantage of. Similar to co-op, you may take an academic year or summer internship with an employer. Internships provide students with insight into what engineers do and the experience can help you decide what direction you want to pursue for your career. An internship can be one quarter, multiple quarters, or you may take internships at different employers each time. To get started, the process is similar to that of co-op – register for CRDV 301 and speak to your ECD advisor. We also recommend registering for 0-unit course CRDV 311 (Professional Engineering Internship) in all quarters you have an internship (including summer) to have your internship show up on your transcripts.

Recruiting for summer opportunities begins as early as Fall quarter in engineering fields. If you are looking for an opportunity for summer, you should be prepared to get the process started 9-10 months in advance. Having your resume up to date at the beginning of each fall is a good way to stay prepared. Check your emails from the department, Engineering Career Development, and Northwestern Career Advancement for information about job postings, career days and info sessions, and career fairs. Searching on your own is also encouraged. Some employers do come to campus to recruit, but many rely on online recruiting.

Here are some of the recent places that ChBE students have completed internships: AbbVie, Argonne National Lab, DOW, Kraft Heinz, Jacobs Engineering, Regeneron Pharmaceuticals, P&G, NanoGraf, and many other places.

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. 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 your transcript. Minors and double majors can be completed in many departments across Northwestern. McCormick also offers

several minors: www.mccormick.northwestern.edu/academics/undergraduate/programs/certificates-and-minors/

If you are interested in pursuing a minor or a double major, you should consult with your advisor at an early stage.

G. Health professions and Pre-med

The Chemical Engineering major can serve as a strong foundation for health professions and 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.

- Not sure yet if health professions are right for you? explorehealthcareers.org
- More information on the various health professions tracks: www.northwestern.edu/health-professions-advising/pre-health-tracks/index.html
- Need an advisor in Health Professions, fill out the intake form: www.northwestern.edu/health-professions-advising/services/get-advising/index.html
- Resources for students in health professions from specific identity groups: www.northwestern.edu/health-professions-advising/diversity-inclusion/identity-pre-health/

H. Study Abroad

Study abroad is compatible with the Chemical Engineering curriculum. The Global Learning Office is the starting place for program information, deadlines, and the application. www.northwestern.edu/abroad/ McCormick students should also work with UG Engineering to complete paperwork for course credit www.mccormick.northwestern.edu/academics/undergraduate/global-opportunities.html . Be sure to consult the Northwestern policies on transfer credits for courses you wish to apply to your degree from study abroad programs www.registrar.northwestern.edu/registration-graduation/transfer-and-test-credit/transfer-credit-policies.html .

Chemical Engineering students often use credits from abroad programs towards the humanities and social sciences theme requirement. Occasionally students find elective courses in chemical engineering, another engineering, or math and science to apply to their technical elective requirements. Rarely do students take core courses abroad due to the difficulty of finding an exact equivalent to the NU course or not feeling comfortable taking a core course in a different language.

Planning considerations for study abroad: If you are interested in pursuing a study abroad program, you should plan early (as early as your first year on campus) so that you can still meet your major program requirements. Because spring semester abroad programs at most international institutions overlap with

Northwestern's Winter and Spring quarters, the most popular time to engage in study abroad is Summer or Fall quarters for Northwestern students. For Chemical Engineering students the most popular quarters for study abroad are Summer after sophomore or junior year or in the Fall of junior year or senior year. If you are studying abroad during the Fall of your junior year (the quarter most students are taking Chem Eng 321 – Fluid Mechanics), you will need to make plans to take ChE 321 in the fall of sophomore year or work with the UG program chair to identify an alternate plan to meet the course requirement.

V. GENERAL INFORMATION

A. Advising

The McCormick School assigns a First Year Advisor to each incoming first-year. At the end of the first year, advisors are reassigned so that you have an advisor in your 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 discussing extracurricular options, such as study abroad; the process for joining a research group; and career choices (temporary or permanent employment, graduate studies, etc.) because of the close relationship developed over the years.

If you wish to switch advisors, you should contact Professor Cole. Any questions that cannot be handled to your satisfaction by your assigned advisor should be addressed to Professor Cole (jennifer-cole@northwestern.edu) the Director of the Undergraduate Program in the department.

B. Academic Honesty

You are expected to maintain high standards of integrity in your 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:
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: researchsafety.northwestern.edu

D. Registration FAQs

Study Plans – Each academic quarter you will meet with your advisor to review your study plan. Getting your advisor to approve your study plan in MAS is important for registration. A hold will be placed on your registration if you fail to get your study plan approved before registration week each quarter.

Needing a permission number for a Chemical Engineering course – Sometimes you may not be able to register for a course even though you meet the prerequisites. This may be because you completed an equivalent course to a listed prerequisite (this often happens for students completing ISP) or you have AP credit or an exemption from a prerequisite course. If this is the case for a chemical engineering course, you will need to request a permission number from our staff. Use this form to complete that request: app.smartsheet.com/b/form/7eda9940e2654f3d970436c232044d5e A staff member will contact you with a permission number or request for further information. For questions about permission numbers in Chemical Engineering use this email: chbepermissions@northwestern.edu

Needing a permission number outside of Chemical Engineering – Unfortunately, we cannot issue permission numbers outside of our department, but here are some good resources for finding who can help you with registration issues:
Specific first-year courses: www.mccormick.northwestern.edu/students/undergraduate/first-year/course-registration.html
Any course: www.registrar.northwestern.edu/registration-graduation/registration/help-with-closed-classes.html

E. 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, https://www.abet.org, under the General Criteria and the Chemical, Biochemical, and Biomolecular and Similarly Named Engineering Programs Program Criteria. 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.

F. 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).

G. ARDEI Committee

The ChBE department's Anti-racism, Diversity, Equity, and Inclusion (ARDEI) committee is comprised of students, staff, and faculty who share the common goal of creating an inclusive and welcoming environment in the department. The committee has developed initiatives such as the annual 'Contextualizing Engineering' seminar, a graduate professional development course, a 'Contextualizing Your Research' workshop, a mental health resource guide, and a workshop to help faculty write homework problems that incorporate anti-racism and social justice contexts. There are many other initiatives that the committee is working on, and they are always looking for new ideas and perspectives. If you are interested in joining please contact chbe_ardei@northwestern.edu.

H. Employment

Work study and paid opportunities in research. Faculty in the department are active in research. Many faculty provide opportunities for undergraduates to participate in exciting new developments in Chemical Engineering. If you are interested in such part-time work (academic year) or full-time summer jobs, you should consult individual faculty and the Work-Study Office for opportunities.

Work study (general). Students eligible for the Federal Work Study program can find opportunities on the NU work study job board. undergradaid.northwestern.edu/work-study/ The ChBE department also hires undergraduates on a limited basis to serve as office help.

Co-op and Internship. For cooperative education opportunities, as well as summer internships with companies, you should consult the McCormick's Engineering Career Development (ECD) office. www.mccormick.northwestern.edu/career-development/ Also read section 4.D. of this handbook for more information.

Post-grad employment. Both McCormick's ECD office and Northwestern Career Advancement (NCA, www.northwestern.edu/careers/) are open to you when searching for permanent employment opportunities. Most on-campus interviews are held very early in the fall quarter, with a small number held winter quarter. **Undergraduates planning to use ECD or NCA 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.**

I. Graduate School Opportunities

If you are considering pursuit of an M.S. or Ph.D. degree in Chemical Engineering, you should talk with your advisors and other faculty. You 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 and most MS programs, 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. If you are interested in pursuing graduate degrees in medicine, law, dentistry, business, etc., you should consult your advisors and the offices at Northwestern specifically set up for this purpose.

J. Assistance and Accommodations

College is not always easy and sometimes we all need help to find the resources we need to be successful. This list provides links to other parts of campus that may be of use to you.

Academic Support and Learning Advancement (ASLA) helps students find the academic support they need to succeed. The office offers study groups, peer tutoring, coaching and strategies for studying. www.northwestern.edu/academic-support-learning/

Accessible NU (ANU) office oversees accommodations for students with disabilities. www.northwestern.edu/accessiblenu/about-us/index.html

Counseling and Psychological Services (CAPS) offers mental health services for students on the Evanston campus. www.northwestern.edu/counseling/

Office of Fellowships helps students connect to fellowship opportunities for a wide variety of ambitions ranging from studying a new language to pursuing research to prestigious post-graduate opportunities to funding for graduate school. www.northwestern.edu/fellowships/index.html

Student Enrichment Services (SES) offers their services to first-generation students, low income students, and/or DACA/Undocumented students. They help students navigate campus resources, host community building groups, as well as emergency financial, food, or legal aid. www.northwestern.edu/enrichment/about/index.html

The Writing Place at Northwestern offers a variety of services to students who have writing assignments, from class papers to undergraduate theses. www.writing.northwestern.edu/

VI. APPENDICES

Appendix A: Sample Course Sequences

STANDARD 4-YEAR CHEMICAL ENGINEERING PROGRAM			
Year:	Fall	Winter	Spring
First-year	Math 220-1	Math 220-2	Math 228-1
	Chemistry[1]	Chemistry[1]	ChE 210[3] or Chemistry[1] or Comp Sci 150[4]
	Gen Eng 205-1	Gen Eng 205-2	Gen Eng 205-3
	Elective	Dsgn 106-1/Eng 106-1	Dsgn 106-2/Eng 106-2
		ChE 101[2]	
Sophomore	Math 228-2	ChE 211	ChE 212
	Organic Chem[1]	Organic Chem[1]	Elective or MSE 301
	Gen Eng 205-4	Phys 135-2	Comp Sci 150[4]
	ChE 210[3] or Elective or Comp Sci 150[4]	Elective or Comp Sci 150[4]	Elective[5,6]
Junior	ChE 321[7]	ChE 322	ChE 307
	Elective[6] or MSE 301	ChE 275[6]	ChE 323
	Elective or speech	ChE 312[8]	Elective[6] or MSE 301
	Elective	Elective	Elective
Senior (variant 1)	ChE 342	ChE 341	ChE 352
	Elective or MSE 301	ChE 351	Elective
	Elective	Elective	Elective
	Elective	Elective	Elective
Senior (variant 2)	ChE 351	ChE 341	ChE 342
	Elective or MSE 301	ChE 352	Elective
	Elective	Elective	Elective
	Elective	Elective	Elective

Notes:

1. General and Organic Chemistry:
   a. The general chemistry requirement is 2 units, which can be fulfilled by Chem 131-132, Chem 151-152, or Chem 171-172 and their associated labs. Students taking Chem 131-132 will begin with Chem 110 which will fulfill one unit of unrestricted electives.
   b. The organic chem requirement is 2 units (Chem 215-1 and 215-2, or 217-1 and 217-2). Students with AP who have tested into organic chemistry may begin taking Chem 215-1 in the Fall of first year, Spring of first year, or Fall of sophomore year. Many students begin the organic sequence in a Fall term. Talk to your advisor about your plan and the pros and cons of each option.

2. Chem Eng 101 is an optional, 0-unit course to introduce the major to interested and declared chemical engineering students. The course only meets in winter quarter.

3. Students who are ahead in the Math sequence or have completed the chemistry sequence may be interested in taking the early offering of **Chem Eng 210** that begins the sophomore sequence of chemical engineering or starting the organic chemistry sequence Chem 215-1 or taking Comp Sci 150. Otherwise, students may take an elective. Students not taking Chem Eng 210 in the Spring of first year must take it in the Fall of sophomore year.

4. Comp Sci 150 should ideally be completed by the end of the sophomore year.

5. Chemistry 215-3 may be taken here as an advanced science elective; a full year of organic chemistry is required to satisfy standard pre-med requirements.

6. Students pursuing a bio-related specialization, or who wish to satisfy pre-med requirements, typically take Biol Sci 201, 202, 203, which begins its sequence in the Spring quarter. Biol Sci 201 or 202 can take the place of ChE 275. Students often begin the Bio sequence in the spring of first of second year.

7. Students interested in Study Abroad may find that any Summer quarter or the Fall quarter of the junior year is a convenient time to go abroad. Chem Eng 321 may be taken early (if prerequisites are met) or students may find a similar course abroad.

8. IEMS 303 may be used in place of Chem Eng 312, however IEMS 303 has prerequisites of IEMS 302 and CS 111. This option may be appealing to students pursuing the Kellogg Certificates.

STANDARD CO-OP (5-YEAR) CHEMICAL ENGINEERING PROGRAM			
Year:	Fall	Winter	Spring
First-year	Math 220-1	Math 220-2	Math 228-1
	Chemistry[1]	Chemistry[1]	ChE 210[3] or Chemistry[1] or Comp Sci 150[4]
	Gen Eng 205-1	Gen Eng 205-2	Gen Eng 205-3
	Elective	Dsgn 106-1/Eng 106-1	Dsgn 106-2/Eng 106-2
		ChE 101[2]	
Sophomore	Math 228-2	ChE 211	ChE 212
	Organic Chem[1]	Organic Chem[1]	Elective or MSE 301
	Gen Eng 205-4	Phys 135-2	Comp Sci 150[4]
	ChE 210[3] or Elective or Comp Sci 150[4]	Elective or Comp Sci 150[4]	Elective[5,6]
Junior	ChE 321	ChE 322	CO-OP[8]
	Elective[6] or MSE 301	ChE 275[6]	
	Elective or speech	ChE 312[7]	
	Elective	Elective	
Pre-Senior	Elective or MSE 301	CO-OP	ChE 307
	Elective		ChE 323
	Elective		Elective[6] or MSE 301
	Elective		Elective
Senior	CO-OP	ChE 341	ChE 342
		ChE 351	ChE 352
		Elective	Elective
		Elective	Elective

Notes:

1. General and Organic Chemistry:
   a. The general chemistry requirement is 2 units, which can be fulfilled by Chem 131-132, Chem 151-152, or Chem 171-172 and their associated labs. Students taking Chem 131-132 will begin with Chem 110 which will fulfill one unit of unrestricted electives.
   b. The organic chem requirement is 2 units (Chem 215-1 and 215-2, or 217-1 and 217-2). Students with AP who have tested into organic chemistry may begin taking Chem 215-1 in the Fall of first year, Spring of first year, or Fall of sophomore year. Many students begin the organic sequence in a Fall term. Talk to your advisor about your plan and the pros and cons of each option.

2. Chem Eng 101 is an optional, 0-unit course to introduce the major to interested and declared chemical engineering students. The course only meets in winter quarter.

3. Students who are ahead in the Math sequence or have completed the chemistry sequence may be interested in taking the early offering of **Chem Eng 210** that begins the sophomore sequence of chemical engineering or starting the organic chemistry sequence Chem 215-1 or taking Comp Sci 150.

Otherwise, students may take an elective. Students not taking Chem Eng 210 in the Spring of first year must take it in the Fall of sophomore year.

4. Comp Sci 150 should ideally be completed by the end of the sophomore year.

5. Chemistry 215-3 may be taken here as an advanced science elective; a full year of organic chemistry is required to satisfy standard pre-med requirements.

6. Students pursuing a bio-related specialization, or who wish to satisfy pre-med requirements, typically take Biol Sci 201, 202, 203, which begins its sequence in the Spring quarter. Biol Sci 201 or 202 can take the place of ChE 275. Students often begin the Bio sequence in the spring of first of second year.

7. IEMS 303 may be used in place of Chem Eng 312, however IEMS 303 has prerequisites of IEMS 302 and CS 111. This option may be appealing to students pursuing the Kellogg Certificates.

8. Students following the traditional co-op schedule typically are on co-op during the summers after the sophomore, junior, and senior years.

Appendix B: Approved Technical Elective Course Listing

Category A

Chemical Engineering (CHEM_ENG)

330-0: Molecular Engineering and Statistical Mechanics
345-0: Process Optimization for Energy and Sustainability
355-0: Chemical Product Design
361-0: Introduction to Polymers
364-0: Chemical Processing & the Environment
365-0: Sustainability, Technology, & Society
367-0: Quantitative Methods in Life Cycle Analysis
372-0: Bionanotechnology
373-0: Biotechnology and Global Health
375-0: Biochemical Engineering
376-0: Synthetic Biology
377-0: Bioseparations
378-0: Deconstructing Synthetic Biology
379-0: Computational Biology: Analysis & Design of Living Systems
382-0: Regulatory Sciences in Biotechnology
395-0: Special Topics in Chemical Engineering (by petition)
All 400-level CHEM ENG classes

Category B (listings by department or educational program)

Biomedical Engineering (BMD_ENG)

271-0: Intro to Biomechanics
304-0: Systems Physiology
305-0: Systems Physiology
306-0: Systems Physiology
311-0: Computational Genomics
312-0: Biomedical Appl in Machine Learning
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 (CIV_ENV)

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
353-0: Energy Geostructures and Geosystems
355-0: Engineering Groundwater Flow
361-1: Environmental Microbiology
361-2: Public & Environmental Health
364-0: Sustainable Water Systems
366-0: Dynamics in Chem Transport and Reaction
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)

Computer Engineering (COMP_ENG)

205-0: Fund of Computer System Software
346-0: Microprocessor System Design
357-0: Design Automation in VLSI

Computer Engineering (COMP_ENG) cont.
358-0: Intro to Parallel Computing
361-0: Comp Architecture I
362-0: Comp Architecture Project
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
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
321-0: Programming Languages
322-0: Compiler Construction
324-0: Dynamics of Programming Languages
325-0: Artificial Intelligence Programming
326-0: Intro to the Data Science Pipeline
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
351-2: Intermediate Computer Graphics
393-0: Software Construction
394-0: Agile Software Development
396-0: Special Topics (by petition)

Electrical Engineering (ELEC_ENG)
202-0: Intro to Electrical Engineering
221-0: Fundamentals of Circuits
222-0: Fundamentals of Signals & Systems
223-0: Fundamentals of Solid State Eng

Electrical Engineering (ELEC_ENG) continued
224-0: Fund of Electromagnetics & Photonics
225-0: Fundamentals of Electronics
250-0: Physical Electronics and Devices
307-0: Communications Systems
308-0: Adv Electromagnetics & Photonics
328-0: Information Theory & Learning
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
375-0: Machine Learning: Found., Appl., & Alg.
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)

Data Science and Engineering (DATA_ENG)
200-0: Foundations of Data Science
300-0: Data Engineering Studio

Design Engineering (DSGN)
305-0: Human-Centered Service Design
308-0: Human-Centered Prod Design
346-0: Manuf. Methods for Prod Design
384-1: Interdisciplinary Design Projects I
384-2: Interdisciplinary Design Projects II
386-0: Manufacturing Engineering Design

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

Industrial Eng and Management Sciences (IEMS)
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: Operations Engineering & Management
383-0: Service Engineering & Management
395-0: Special Topics (by petition)

Materials Science and Engineering (MAT_SCI)
314-0: Thermodynamics of Materials
315-0: Phase Equilibria & Diffusion of Mats
316-1: Microstructural Dynamics
316-2: Microstructural Dynamics
318-0: Materials Selection
331-0: Soft Materials
332-0: Mechanical Behavior of Solids
336-0: Synthetic Design of New Materials
340-0: Ceramic Processing
351-2: Intro Physics of Materials
353-0: Bioelectronics
355-0: Electronic Materials
357-0: Nanomagnetic Materials
360-0: Intro to Electron Microscopy
371-0: Biominerals: Hierarchical Arch. & Fn.
376-0: Nanomaterials
380-0: Intro Surface Sci & Spectroscopy
381-0: Materials for Energy Eff. Technology

Materials Science and Engineering (MAT_SCI) cont.
382-0: Electrochem Energy Mats & Devices
385-0: Electronic/Thermal Properties Matls
390-0: Materials Design
391-0: Process Design
395-0: Special Topics (by petition)

Mechanical Engineering
224-0: Scientific & Embed Programming in Python
233-0: Electronics Design
240-0: Mechanical Design & Manufacturing
314-0: Machines Dynamics
315-0: Theory of Machines: Design Elements
320-0: Micro- & Nanomechanical Prop. of Surfaces
329-0: Mechanistic Data Science for Engineering
333-0: Introduction to Mechatronics
340-1: Computer Integ Manuf: Manuf. Processes
340-2: Computer Integ Manuf: CAD/CAM
340-3: Computer Integ Manuf: Automation
341-0: Computational Methods for Eng Design
346-0: Intro to Tribology
359-0: Reliability Engineering
362-0: Stress Analysis
363-0: Mechanical Vibrations
364-0: Introduction to Aerospace Engineering
371-0: Combustion Engines
373-0: Engg Fluid Mechanics
377-0: Heat Transfer
378-0: Applied Comp. Fluid Dyn & Heat Transfer
380-0: Thermal Energy Systems Design
381-0: Intro to MEMS
382-0: Expts in Micro/Nano Sci and Engg
390-0: Intro Dynamic Systems
395-0: Special Topics (by petition)

Category C (listings by department or educational program)

Biological Sciences (BIOL_SCI, in Weinberg)
201-0: Molecular Biology
202-0: Cell Biology
203-0: Genetics and Evolution
240-0: Biochem, Molec & Cell Biology for ISP 1
241-0: Biochem, Molec & Cell Biology for ISP 2
301-0: Principles of Biochemistry
315-0: Advanced Cell Biology
319-0: Biology of Animal Viruses
323-0: Bioinformatics
325-0: Animal Physiology
328-0: Microbiology
332-0: Conservation Genetics
333-0: Plant-Animal Interactions
337-0: Biostatistics
338-0: Modeling Biological Dynamics
341-0: Population Genetics
354-0: Systems Biology
355-0: Immunobiology
360-0: Principles of Cell Signaling
361-0: Protein Structure and Function
363-0: Biophysics
378-0: Functional Genomics
380-0: Biology of Cancer
390-0: Molecular Bio of Genome Edit & Eng
395-0: Molecular Genetics

Chemistry (CHEM, in Weinberg)
215-3: Advanced Organic Chemistry
220-0: Introductory Instrumental Analysis
301-0: Principles Organic Chemistry
302-0: Principles Inorganic Chemistry
303-0: Principles of Physical Chemistry
305-0: Chemistry of Life Processes
306-0: Environmental Chemistry
307-0: Supramolec. Design of Matls & Nanochem
313-0: Advanced Organic Chemistry
314-0: Principles of Chemical Biology

Chemistry (CHEM) continued
316-0: Medicinal Chemistry
319-0: Advanced Organic Synthesis
333-0: Inorganic Chemistry
342-1: Thermodynamics
342-2: Quantum Mech and Spectroscopy
342-3: Kinetics and Stat Thermodynamics
348-0: Physical Chemistry for ISP
350-1: Advanced Laboratory 1
350-2: Advanced Laboratory 2
350-3: Advanced Laboratory 3
393-0: Green Chemistry

Civil and Environmental Engineering (CIV_ENV)
202-0: Biol. & Ecological Principles
203-0: Earth in the Anthropocene
317-0: Biogeochemistry

Eng Sciences & Applied Mathematics (ES_APPM)
311-0: Methods of Applied Mathematics
312-0: Complex Variables
346-0: Modeling/Computation

Environmental Sciences (ENVR_SCI, in Weinberg)
201-0: Earth: A Habitable Planet
202-0: The Health of the Biosphere

Mathematics (MATH, in Weinberg)
310-1: Probability and Stochastic Processes
310-2: Probability and Stochastic Processes
310-3: Probability and Stochastic Processes
314-0: Prob and Statistics for Econometrics
325-0: Complex Analysis
351-0: Fourier Analysis and Boundary Value
353-0: Qualitative Theory Differential Equations
354-0: Chaotic Dynamical Systems
360-1: MENU: Applied Analysis
360-2: MENU: Applied Analysis
365-0: Computational Methods in Mathematics

Mathematics (MATH) continued
366-0: Mathematical Models in Finance
368-0: Intro Optimization
381-0: Fourier Analysis & Boundary Value for ISP
382-0: Complex Analysis for ISP

Materials Science and Engineering (MAT_SCI)
361-0: Crystallography & Diffraction

Physics (PHYSICS, in Weinberg)
330-1: Classical Mechanics

Physics (PHYSICS) continued
330-2: Classical Mechanics
332-0: Statistical Mechanics
333-1: Adv Electricity and Magnetism
333-2: Adv Electricity and Magnetism
337-0: Physics of Condensed Matter
339-1: Quantum Mechanics for ISP
339-2: Quantum Mechanics for ISP
352-0: Intro to Computational Physics
357-0: Optics Laboratory

Category D (listings by engineering department or educational program)

Civil and Environmental Engineering (CIV_ENV)
304-0: Civil/Envr Eng Syst Analysis
306-0: Uncertainty Analysis

Computer Science (COMP_SCI)
330-0: Human Computer Interaction
335-0: Intro to the Theory of Computation
336-0: Design Analysis Algorithms
370-0: Computer Game Design

Computer Engineering (COMP_ENG)
203-0: Intro to Computer Eng
303-0: Adv Digital Logic Design

Electrical Engineering (ELECT_ENG)
221-0: Fundamentals of Circuits
222-0: Fundamentals of Signals & Systems
223-0: Fund of Solid State Engineering
224-0: Fund of Electromagnetics & Photonics
302-0: Probabilistic Systems
381-0: Electronic Properties of Materials
384-0: Solid State Electronic Devices
385-0: Optoelectronics
388-0: Nanotechnology
389-0: Superconductivity Applications

Eng Sciences and Applied Mathematics (ES_APPM)
345-0: Applied Linear Algebra
375-1: Quantitative Biology I
375-2: Quantitative Biology II

Design Engineering (DSGN)
(may combine 2 half unit courses)
240-0: Solid Modeling (0.5 unit)
306-0: User Experience Design
320-0: Intro Industrial Design Methods
321-0: Adv Solid Modeling (0.5 unit)
345-0: Computer-Aid Manufact (0.5 unit)
348-0: Rapid Prototyping (0.5-1 unit)
350-0: Intellectual Property and Innovation
380-1: Industrial Design Projects I
380-2: Industrial Design Projects II

Industrial Engg and Management Sciences (IEMS)
302-0: 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 (MAT_SCI)
337-0: Conducting Polymers
351-1: Intro Physics of Materials
371-0: Biominerals: Hierarchical Archt/Funct

Physics (PHYSICS)
135-3: General Physics: Modern & Waves