Curriculum for Class of 2021, 2022 and 2023

Minimum units required for B.S. in Chemical Engineering 389

The program in chemical engineering within the Department of Chemical Engineering is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org.

First Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-120 Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>76-xxx Designated Writing/Expression Course</td>
<td>9</td>
</tr>
<tr>
<td>99-101 Computing @ Carnegie Mellon</td>
<td>3</td>
</tr>
<tr>
<td>06-100 Introduction to Chemical Engineering</td>
<td>12</td>
</tr>
<tr>
<td>09-105 Introduction to Modern Chemistry I</td>
<td>10</td>
</tr>
</tbody>
</table>
Third Year

Following required basic science and computer science courses:

At the end of the Sophomore year, a student should have completed the General Education Course normally taken during that semester may be postponed until the Junior year. These units will take 36-220.

Notes:

1. In addition to the graduation requirement of an overall QPA of 2.0 (not counting the First Year), the Department of Chemical Engineering requires a cumulative QPA of 2.0 in all chemical engineering courses (all those numbered 06-xxx).
2. Minimum number of units required for graduation: 389.
3. All mathematics (21-xxx) courses required for the engineering degree taken at Carnegie Mellon must have a minimum grade of C in order to be counted toward the graduation requirement for the BS engineering degree.
4. A minimum grade of C must be achieved in any required mathematics (21-xxx) course that is a prerequisite for the next higher level required mathematics (21-xxx) course.
5. Overloads are permitted only for students maintaining a QPA of 3.5 or better during the preceding semester.
6. Electives: To obtain a Bachelor of Science degree in Chemical Engineering, students must complete 06-100 and one other Introductory Engineering Elective. There are also five Unrestricted Electives. Students must discuss choice of electives with their faculty advisors.
7. Undergraduate Research: Independent research projects are available by arrangement with a faculty advisor. Many students conduct such research projects for elective credit by enrolling in 06-200, 06-300, or 06-400 (Sophomore, Junior, or Senior Research Projects) or 39-500 CIT Honors Research Project for eligible Seniors.
8. Advanced undergraduates may also take Chemical Engineering graduate courses (600+ level).

Curriculum for Class of 2024

Minimum units required for B.S. in Chemical Engineering: 389

The program in chemical engineering within the Department of Chemical Engineering is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org.

FIRST YEAR

Fall

Units
21-120 Differential and Integral Calculus 10
76-xxxx Designated Writing/Expression Course 9
99-101 Computing @ Carnegie Mellon 3
06-100 Introduction to Chemical Engineering 12
09-105 Introduction to Modern Chemistry I 10

Units 44

Spring

Units
21-122 Integration and Approximation 10

Units 10

Notes:

** Students pursuing a Chemical Engineering/Engineering and Public Policy double major are waived from taking the Biochemistry Elective. They will take 36-220.
THIRD YEAR
At the end of the Sophomore year, a student should have completed the students should consult with their faculty advisors as soon as possible. taken during that semester may be postponed until the Junior year. These

SECOND YEAR
Fall Units
21-259 Calculus in Three Dimensions 9-11
or 21-254 Linear Algebra and Vector Calculus for Engineers 10
06-222 Sophomore Chemical Engineering Seminar 1
09-106 Modern Chemistry II 10
xx-xxx Computer Sci./Physics II * 10-12
xx-xxx General Education Course 9
39-210 Experiential Learning I 0

Spring Units
06-261 Fluid Mechanics 9
06-262 Mathematical Methods of Chemical Engineering 12
09-221 Laboratory I: Introduction to Chemical Analysis 12
xx-xxx Physics II/Computer Sci. * 12-10
xx-xxx General Education Course 9
39-220 Experiential Learning II 0

* Computer Science/Physics II: Students should complete 15-110 Principles of Computing or 15-112 Fundamentals of Programming and Computer Science as well as 33-142 Physics II for Engineering and Physics Students by the end of the Sophomore year. The recommended sequence is 33-141 /33-142 for engineering students, however, 33-151/ 33-152 will also meet the CIT Physics requirement.

For those students who have not taken 06-100 as one of the two Introductory Engineering Electives, 06-100 should be taken in the Fall Semester of the Sophomore year. The General Education Course normally taken during that semester may be postponed until the Junior year. These students should consult with their faculty advisors as soon as possible.

At the end of the Sophomore year, a student should have completed the following required basic science and computer science courses:

09-105 Introduction to Modern Chemistry I 10
09-106 Modern Chemistry II 10
09-221 Laboratory I: Introduction to Chemical Analysis 12
15-110 Principles of Computing 10-12
15-111 Fundamentals of Programming and Computer Science 10

or 15-112

33-141 Physics I for Engineering Students 12
33-142 Physics II for Engineering and Physics Students 12
99-10x Computing @ Carnegie Mellon 3

THIRD YEAR
Fall Units
06-325 Numerical Methods and Machine Learning for Chemical Engineering 6
06-326 Optimization Modeling and Algorithms 6
06-322 Junior Chemical Engineering Seminar 2
09-217 Heat and Mass Transfer 9
09-219 Organic Chemistry I 9-10
or 09-219 Modern Organic Chemistry
06-310 Molecular Foundations of Chemical Engineering 9
xx-xxx General Education Course 9
39-310 Experiential Learning III 0

Spring Units
06-361 Unit Operations of Chemical Engineering 9
06-363 Transport Process Laboratory 9
06-364 Chemical Reaction Engineering 9
xx-xxx Advanced Chemistry Elective** 9

FOURTH YEAR
Fall Units
06-421 Chemical Process Systems Design 12
06-423 Unit Operations Laboratory 9
xx-xxx Unrestricted Elective 9
xx-xxx Unrestricted Elective 9
xx-xxx General Education Course 9

Spring Units
06-463 Chemical Product Design 9
06-464 Chemical Engineering Process Control 9
xx-xxx Unrestricted Elective 9
xx-xxx Unrestricted Elective 9
xx-xxx General Education Course 9

** Students pursuing a Chemical Engineering/Engineering and Public Policy double major are waived from taking the Advanced Chemistry Elective. They will take 36-220.

*** Advanced Chemistry Elective may be any technical course offered by the Department of Chemistry for at least 9 units at the 200-level or above (such as Organic chemistry 2), or one of the following: 03-232 Biochemistry I, 06-607 Physical Chemistry of Colloids and Surfaces, or 06-609/09-509 Physical Chemistry of Macromolecules. Students may petition the Undergraduate Committee to approve other chemistry-focused courses offered by other departments on a case-by-case basis.

**** 06-463 Chemical Product Design for Classes of 2024 and beyond is a 9 unit course. For Classes up to 2023, it is a 6 unit course. The 06-463 Chemical Product Design requirement is waived for students completing 42-401 Foundation of BME Design (6 units, fall) AND 42-402 BME Design Project (9 units, spring).

NOTES:
- In addition to the graduation requirement of an overall QPA of 2.0 (not counting the First Year), the Department of Chemical Engineering requires a cumulative QPA of 2.0 in all chemical engineering courses (all those numbered 06-xxx).
- Minimum number of units required for graduation: 389.
- All mathematics (21-xxx) courses required for the engineering degree taken at Carnegie Mellon must have a minimum grade of C in order to be counted toward the graduation requirement for the BS engineering degree.
- A minimum grade of C must be achieved in any required mathematics (21-xxx) course that is a pre-requisite for the next higher level required mathematics (21-xxx) course.
- Overloads are permitted only for students maintaining a QPA of 3.5 or better during the preceding semester.
- Electives: To obtain a Bachelor of Science degree in Chemical Engineering, students must complete 06-100 and one other Introductory Engineering Elective. There are also five Unrestricted Electives. Students must discuss choice of electives with their faculty advisors. Undergraduate Research: Independent research projects are available by arrangement with a faculty advisor. Many students conduct these research projects for elective credit by enrolling in 06-200, 06-300, or 06-400 (Sophomore, Junior, or Senior Research Projects) or 39-500 CIT Honors Research Project for eligible Seniors.
- Advanced undergraduates may also take Chemical Engineering graduate courses (600+ level).
The program in chemical engineering within the Department of Chemical Engineering is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org.

### First Year

<table>
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<tr>
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<tbody>
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<tr>
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<tr>
<td>09-105  Introduction to Modern Chemistry I</td>
<td>10</td>
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<tr>
<td>Spring</td>
<td></td>
</tr>
<tr>
<td>21-122  Integration and Approximation</td>
<td>10</td>
</tr>
<tr>
<td>xx-xxx  Introductory Engineering Elective (other than Che)</td>
<td>12</td>
</tr>
<tr>
<td>33-141  Physics I for Engineering Students</td>
<td>12</td>
</tr>
<tr>
<td>xx-xxx  General Education Course</td>
<td>9</td>
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<tr>
<td><strong>44</strong></td>
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</tbody>
</table>

### Second Year

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<td>21-254  Linear Algebra and Vector Calculus for Engineers</td>
<td>11</td>
</tr>
<tr>
<td>06-223  Chemical Engineering Thermodynamics</td>
<td>12</td>
</tr>
<tr>
<td>06-222  Sophomore Chemical Engineering Seminar</td>
<td>1</td>
</tr>
<tr>
<td>09-106  Modern Chemistry II</td>
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<td>xx-xxx  Computer Sci./Physics II *</td>
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<td>9</td>
</tr>
<tr>
<td>39-210  Experiential Learning I</td>
<td>0</td>
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<tr>
<td><strong>53-55</strong></td>
<td></td>
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<tr>
<td>Spring</td>
<td></td>
</tr>
<tr>
<td>06-261  Fluid Mechanics</td>
<td>9</td>
</tr>
<tr>
<td>06-262  Mathematical Methods of Chemical Engineering</td>
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</tr>
<tr>
<td>09-211  Laboratory I: Introduction to Chemical Analysis</td>
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</tr>
<tr>
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</tr>
<tr>
<td>xx-xxx  General Education Course</td>
<td>9</td>
</tr>
<tr>
<td>39-220  Experiential Learning II</td>
<td>0</td>
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<td><strong>54-52</strong></td>
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<td>15-110  Principles of Computing</td>
<td>10-12</td>
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8. Advanced undergraduates may also take Chemical Engineering graduate courses (600+ level).

Additional Major in Engineering and Public Policy (EPP)
Students may pursue a double major in Chemical Engineering and EPP. This double major is built around electives in Social Analysis, Probability and Statistics courses, and projects. Specific course choices should be discussed with a faculty advisor and an EPP advisor.

Additional Major in Biomedical Engineering (BME)
Students may pursue a double major in Chemical Engineering and BME. Specific course choices should be discussed with a faculty advisor and a BME advisor.

Minors with a B.S. in Chemical Engineering
Chemical Engineering students are eligible for any CIT Designated Minor. Those minors that are especially well suited to Chemical Engineers include: Audio Engineering, Automation and Controls, Biomedical Engineering, Colloids, Polymers & Surfaces, Electronic Materials, Environmental Engineering, Global Engineering, Manufacturing Engineering, Materials Science and Engineering, Mechanical Behavior of Materials, and Robotics. The minor requirements may be fulfilled with electives. Other minors, such as the Supply Chain Management minor in association with the Tepper School of Business, are also available outside of CIT. These should be discussed with a faculty advisor.

Colloids, Polymers and Surfaces Minor
Professor Robert Tilton, Director of CPS Minor
Location: Doherty Hall 2100B
The sequence of courses in the Colloids, Polymers and Surfaces (CPS) designated minor provides an opportunity to explore the science and engineering of fine particles and macromolecules as they relate to complex fluids and interfacially engineered materials. These topics are very relevant to technology and product development in industries that manufacture pharmaceuticals, coatings and paints, pulp and paper, biomaterials, surfactants and cleaning products, cosmetics and personal care products, food, textiles and fibers, nanoparticles, polymer/plastics, composite materials.

Course Requirements
Minimum units required for minor: 45
This minor requires a total of five classes with a minimum of 45 units. The following four courses are mandatory:
06-609/09-509 Physical Chemistry of Macromolecules 9
06-607 Physical Chemistry of Colloids and Surfaces 9
06-426 Experimental Colloid Surface Science 9
06-466 Experimental Polymer Science 9
In addition, the student must take one CPS related elective course from the following list:
06-612 Formulation Engineering 12
06-610 Rheology and Structure of Complex Fluids 9
09-502 Organic Chemistry of Polymers 9
27-565 Nanostructured Materials 9
27-568 Polymer Physics and Morphology 9
Other CPS electives are possible but must be approved by the Director of the CPS minor, Professor Tilton.

The Chemical Engineering curriculum develops deep problem solving skills through challenging, open-ended problems in chemical engineering science, process systems engineering, process system design and product design. Computing is integrated throughout the curriculum. The department’s Gary J. Powers Educational Computer Lab supports extensive use of mathematical modeling and simulation software. Students in the Robert Robinson Laboratory and Lubrizol Analytical Laboratory learn to use computerized data acquisition and control systems as they develop experimental tests of chemical engineering theory or process design alternatives. With its focus on complex chemical and biochemical processes, Chemical Engineering is a natural pairing with the Additional Major in Biomedical Engineering or the Biomedical Engineering minor. Chemical Engineering students pursue many different minors. It is particularly well aligned with the CIT Designated Minor in Colloids, Polymers and Surfaces and the University’s Minor in Environmental and Sustainability Studies.

Practical Internships for Senior Chemical Engineering Students (PISCES)
Chemical Engineering students may apply in the fall of their Junior year for a one-year PISCES internship with a partner company. Admitted students begin their internships after completion of the Junior year. Following the internship, students return to complete their Senior year. There are several advantages of a one full-year internship, including the opportunity to gain a breadth of professional experience that is not generally possible in a shorter program, more opportunity to make important contributions to the partner company, and the opportunity to complete Senior year courses in their normal sequence with no need for curriculum rearrangements. Interested students should consult with their faculty advisors.

International Chemical Engineering Exchange Programs
Chemical Engineering students may apply during their Sophomore year to spend their Junior year at RWTH Aachen in Germany, Yonsei University in Seoul, Korea, Universidad Nacional del Litoral in Argentina, or at Imperial College in London, Great Britain. A summer exchange program in Dortmund, Germany is also available. These exchange programs provide a great opportunity for students to obtain international experience while taking courses very similar to those offered at Carnegie Mellon. Students considering any of these programs should consult with their faculty advisors, and students considering the Aachen program in particular are advised to take at least one introductory German course before or during their Sophomore year.

Fifth Year Master of Chemical Engineering (MChE)
The CIT Integrated Masters/Bachelors (IMB) Degree program provides the opportunity for qualified undergraduate students to obtain a master’s degree in Chemical Engineering with one or two extra semesters of study. The goal is to deepen our graduates’ understanding of the fundamentals of chemical engineering, and to provide them with a broader set of professional skills or to expose them to other technical disciplines.

The MChE program is a 96 unit course work degree aimed at undergraduate students from Carnegie Mellon and candidates from other universities. Unfortunately, no financial support is available. For Carnegie Mellon students, the degree typically would be completed in their fifth year. Depending on advanced placement and semester overloads, however, CMU students can complete the degree at the time of the B.S. graduation or with one additional semester. All students must have graduate status once they have completed their B.S. degree; beyond eight semesters, degree program students must have full-time graduate student status in at least one (e.g., their final) semester whether or not they have already
Department of Chemical Engineering

completed their BS degree. Upon graduating from this program, students seek industrial positions or placement in graduate programs at other universities. Students in the MChE program may apply for the PhD program at Carnegie Mellon University via the normal application process. Their applications are considered alongside all the other applications received that year. If accepted into the PhD program, they enter it after completing the MChE degree.

A minimum of five completed semesters in residence as an undergraduate student and an overall QPA of 3.0 is required for eligibility. Taking the GRE and recommendation letters are not required. The application fee is waived for currently-enrolled undergraduate Chemical Engineering students.

The MChE program differs from the MS program because the MChE program does not require a project report or thesis.

Faculty

SHELLEY ANNA, Professor of Chemical Engineering – Ph.D., Harvard University; Carnegie Mellon, 2003-

JOANNE BECKWITH, Assistant Teaching Professor of Chemical Engineering – Ph.D., University of Michigan; Carnegie Mellon, 2022-

LORENZ T. BIEGLER, University Professor and Covestro Professor of Chemical Engineering – Ph.D., University of Wisconsin; Carnegie Mellon, 1981-

WUI YARN (DAPHNE) CHAN, Assistant Professor of Chemical Engineering – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2022--

MICHAEL M. DOMACH, Emeritus, Professor of Chemical Engineering – Ph.D., Cornell University; Carnegie Mellon, 1983-

NEIL M. DONAHUE, Lord University Professor of Chemistry and Chemical Engineering – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2000-

ANDREW J. GELLMAN, Lord Professor of Chemical Engineering – Ph.D., University of California, Berkeley; Carnegie Mellon, 1992-

GABRIEL GOMES, Assistant Professor of Chemistry and Chemical Engineering – Ph.D., Florida State University; Carnegie Mellon, 2022-

HAMISH GORDON, Assistant Professor of Chemical Engineering – Ph.D., University of Oxford; Carnegie Mellon, 2022-

CHRYSANTHOS GOUNARIS, Professor of Chemical Engineering – Ph.D., Princeton University; Carnegie Mellon, 2013-

IGNACIO E. GROSSMANN, University Dean Professor of Chemical Engineering – Ph.D., Imperial College, University of London; Carnegie Mellon, 1979-

COTY JEN, Assistant Professor of Chemical Engineering – Ph.D., University of Minnesota; Carnegie Mellon, 2018-

MYUNG S. JHON, Emeritus, Professor of Chemical Engineering – Ph.D., University of Chicago; Carnegie Mellon, 1980-

ADITYA KHAIR, Professor of Chemical Engineering – PhD, California Institute of Technology; Carnegie Mellon, 2010–

JOHN KITCHIN, Professor of Chemical Engineering – Ph.D., University of Delaware; Carnegie Mellon, 2006-

CARL LAIRD, Professor of Chemical Engineering – Ph.D., Carnegie Mellon; Carnegie Mellon, 2021-

GRIGORIOS PANAGAKOS, Assistant Research Professor – Ph.D., Technical University of Denmark; Carnegie Mellon, 2018-

DENNIS C. PRIEVE, Emeritus, Gulf Professor of Chemical Engineering – Ph.D., University of Delaware; Carnegie Mellon, 1974-

ANNE SKAJA ROBINSON, Trustee Professor of Chemical Engineering, Head of Department – Ph.D., University of Illinois at Urbana-Champaign; Carnegie Mellon, 2019–

NIKOLAOS V. SAHINIDIS, Adjunct Professor of Chemical Engineering – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2007–

JAMES W. SCHNEIDER, Professor of Chemical Engineering – Ph.D., University of Minnesota; Carnegie Mellon, 1999-

PAUL J. SIDES, Emeritus, Professor of Chemical Engineering – Ph.D., University of California, Berkeley; Carnegie Mellon, 1981–

SUSANA C. STEPPAN, Emeritus, Associate Teaching Professor – PhD, University of Massachusetts; Carnegie Mellon, 2004–

ROBERT D. TILTON, Chevron Professor of Chemical Engineering – Ph.D., Stanford University; Carnegie Mellon, 1992–

ANA INES TORRES, Assistant Professor of Chemical Engineering – Ph.D., University of Minnesota; Carnegie Mellon, 2022–

ZACHARY ULISSI, Associate Professor of Chemical Engineering – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2017–

LYNN M. WALKER, Professor of Chemical Engineering – Ph.D., University of Delaware; Carnegie Mellon, 1997–

ELIZABETH WAYNE, Assistant Professor of Chemical Engineering and Biomedical Engineering – PhD, Cornell; Carnegie Mellon, 2019–

ARTHUR W. WESTERBERG, Emeritus, University Professor of Chemical Engineering – Ph.D., DIC, Imperial College, University of London; Carnegie Mellon, 1976–

KATHRYN WHITEHEAD, Professor of Chemical Engineering – Ph.D., University of California; Carnegie Mellon, 2012–

B. ERIK YDSTIE, Emeritus, Professor of Chemical Engineering – Ph.D., Imperial College, University of London; Carnegie Mellon, 1992–