Department of Chemical Engineering

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www.cmu.edu/cheme (http://www.cmu.edu/cheme/)

Chemical engineering is a broad discipline based on chemistry, mathematics, physics and biology. Chemical engineers work collaboratively toward the development and commercialization of new products and processes by applying principles of chemical engineering science and process systems engineering. Chemical engineering science refers to the data and models that help the chemical engineer understand and predict the transport and transformation of chemicals in processes. Process systems engineering provides methodologies for the systematic design, control, operations and analysis of these processes, as well as their economic evaluation, safety and environmental assessment.

The chemical engineering profession offers challenging and well-compensated careers in numerous industries, including high-technology areas. Chemical engineers design safe, efficient and environmentally friendly chemical processes, supervise the operation of chemical plants, and develop new products and processes. In the chemicals and petroleum industry, chemical engineers develop catalysts and new reaction and separation units to improve yields in the production of fuels and commodity chemicals. Chemical engineers are also found in industries associated with polymers (plastics and resins) and coatings (paint, integrated circuits, magnetic tapes). The pharmaceutical industry recruits chemical engineers who possess expertise in both process engineering and biochemistry/molecular biology. In the semiconductor industry, chemical engineers supervise the processing of complex polymers, chip fabrication and production of thin films. Many consulting companies seek chemical engineers for evaluation of the economic feasibility of industrial projects, and for software development for the design, analysis and operation of chemical processes. Finally, the depth and breadth of coursework makes chemical engineering an excellent preparatory major for students interested in medical and business schools.

The department emphasizes ethical problem-solving techniques in the learning of basic principles in chemical engineering science and process systems engineering. Computing is integrated throughout the curriculum and extensive use is made of software for mathematical modeling and simulation in the department’s Gary J. Powers Educational Computer Lab. The Robert Rothus Laboratory and Lubrizol Analytical Laboratory feature hands-on experiments that illustrate applications in safety, environmental, product development, and computerized data acquisition and control. In addition to several engineering minors, the Colloids, Polymers and Surfaces option is also available, as well as a minor in Manufacturing Management and Consulting, and the double major in Biomedical and Health Engineering.

Program Educational Objectives and Student Outcomes

Program Educational Objectives: The objectives for the program are that within a few years after graduation, graduates will obtain employment and attend graduate school, will advance in their chosen careers, and will be productive and fulfilled professionals. The curriculum and programs are developed to prepare students to attain these educational objectives.

Students majoring in chemical engineering learn the science and engineering that govern chemical processing systems. Fundamental principles, problem solving, systems analysis and design, development of self-confidence, and communication skills are emphasized. Students are made aware of modern tools, industrial needs and societal issues. The curriculum emphasizes the acquisition of knowledge in basic science and mathematics during the first three semesters, acquisition and exercise of knowledge about engineering science in the next three semesters, and acquisition of knowledge and experience with chemical engineering design in the final two semesters. Moreover, lab courses emphasize projects where students work on innovative ideas and decide what equipment to build or use in order to carry out those ideas. This combination of fundamental knowledge and practical skills provides a firm foundation for future learning and career growth. The goal of the department is to produce students who will become leaders in their careers.

Student Outcomes: The Program has adopted the Student Outcomes listed in the 2018-2019 Criteria for Accrediting Engineering Programs. Students who complete the curriculum will have attained the following outcomes:

- an ability to function on multidisciplinary teams
- an ability to identify, formulate, and solve engineering problems
- an understanding of professional and ethical responsibility
- an ability to communicate effectively
- the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- a recognition of the need for, and an ability to engage in, life-long learning
- a knowledge of contemporary issues
- an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

The department offers a number of special programs for students majoring in Chemical Engineering. In addition to the double majors offered by the College of Engineering such as Biomedical Engineering and Engineering & Public Policy, students may choose from a variety of minors in technical areas offered by the College of Engineering. Undergraduate research projects are also available in the areas of bioengineering, complex fluids engineering, environmental engineering, process systems engineering, and catalysis & surface science. The department has recently established the Chemical Engineering Summer Scholars (ChESS) program to support undergraduate research within the department. Students may participate in study abroad programs during their junior year. In addition to the University program with EPFL in Switzerland and ITESM Monterey in Mexico, the department provides its own exchange programs with Yonsei University in Seoul, Korea, RWTH Aachen in Germany, Universidad Nacional del Litoral in Argentina, and Imperial College in London, Great Britain. Students may also participate in Practical Internships for Senior Chemical Engineering Students, a one-year industrial internship program offered between the Junior and Senior years. Finally, qualified students may enroll in our Master of Chemical Engineering program. This degree is typically completed in the fifth year. However, depending on the number of advanced placement courses and course load at Carnegie Mellon, this degree could be awarded during the B.S. graduation, or after one additional semester.

Curriculum

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

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<tr>
<th>Units</th>
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<th>Spring</th>
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<tr>
<td>10</td>
<td>21-120 Differential and Integral Calculus</td>
<td>21-122 Integration and Approximation</td>
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<td>9</td>
<td>76-xxxx Designated Writing/Expression Course</td>
<td>xx-xxxx Introductory Engineering Elective (other than ChE)</td>
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<td>99-101 Computing @ Carnegie Mellon</td>
<td>33-141 Physics I for Engineering Students</td>
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<td>06-100 Introduction to Chemical Engineering</td>
<td>xx-xxxx General Education Course</td>
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<td>09-105 Introduction to Modern Chemistry I</td>
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Second Year

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<tr>
<td>9</td>
<td>21-259 Calculus in Three Dimensions</td>
<td>06-221 Thermodynamics</td>
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<td>06-222 Sophomore Chemical Engineering Seminar</td>
<td>09-106 Modern Chemistry II</td>
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<td>xx-xxxx Computer Sci./Physics II *</td>
<td>xx-xxxx General Education Course</td>
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<td>06-221 Thermodynamics</td>
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* xx-xxxx General Education Course
Fourth Year

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<td>Unrestricted Elective</td>
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<tr>
<td>xx-xxx</td>
<td>General Education Course</td>
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** Notes:

1. In addition to the graduation requirement of an overall GPA of 2.0 (not counting the First Year), the Department of Chemical Engineering requires a cumulative GPA 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 pre-requisite for the next higher level required mathematics (21-xxx) course.
5. Overloads are permitted only for students maintaining a GPA 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 these research projects for elective credit by enrolling in 06-200 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).

Double 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.

Double 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

Dr. Ilhem Hakem, Director
Location: Doherty Hall 3207

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, polymerplastics, 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
- 27-588 Polymer Physics and Morphology 9

Other CPS electives are possible but must be approved by the Director of the CPS minor, Dr. Hakem

Practical Internships for Senior Chemical Engineering Students (PISCES)

Chemical Engineering students may apply in the fall of their Junior year for a salaried, 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 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 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 GPA 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.

Research and Teaching Faculty

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

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

KRIS N. DAHL, Professor of Chemical Engineering – Ph.D., University of Pennsylvania; Carnegie Mellon, 2006–

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

NEIL M. DONAHUE, Lord 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–

CHRYSANTHOS GOUNARIS, Associate 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–

ILHEM-FAIZA HAKEM, Assistant Teaching Professor – Ph.D., Telmcen University; Carnegie Mellon, 2018–

ANNETTE M. JACOBSON, Teaching Professor – Ph.D., University of Minnesota; Carnegie Mellon, 2018–

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

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

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

JOHN KITCHIN, Professor of Chemical Engineering – PhD, University of Delaware; Carnegie Mellon, 2006–

SPYROS N. PANDIS, Research Professor of Chemical Engineering and Engineering and Public Policy – Ph.D., California Institute of Technology; Carnegie Mellon, 1993–

DENNIS C. PRIEVE, Emeritus – Ph.D., University of Delaware; Carnegie Mellon, 1974–

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

ALAN RUSSELL, Highmark Distinguished Career Professor of Chemical Engineering – Ph.D., Imperial College, London; Carnegie Mellon, 2012–

NIKOLAOS V. SAHINIDIS, John E. Swearengen 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 – Ph.D., University of California, Berkeley; Carnegie Mellon, 1981–

JEFFREY J. SIROLA, Distinguished Service Professor – PhD, University of Wisconsin; Carnegie Mellon, 2011–
SUSANA C. STEPPAN, 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–

ZACHARY ULISSI, Assistant 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 – 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, Associate Professor of Chemical Engineering – Ph.D., University of California; Carnegie Mellon, 2012–

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