Cantonese

See Asian and Near Eastern Languages.

Catalan

See Center for Language Studies.

Cebuano

See Center for Language Studies.

Chemical Engineering

W. Vincent Wilding, Chair
350 CB, (801) 422-2393

Ira A. Fulton College of Engineering and Technology Advisement Center
264 CB, (801) 422-4325

Admission to Degree Program

The chemical engineering degree program is open to all students.

The Discipline

Chemical engineering is the application of chemistry, biology, physics, mathematics, computer skills, and economics to designing, developing, and implementing chemical processes that convert raw materials into more useful, valuable products. Engineering skills are required for design, testing, scale-up, operation, control, and optimization. Applications range in size from the molecular level to large chemical production facilities, with objectives ranging from economic performance to protection of the environment and the safety of workers and consumers. Chemical engineers are engaged in developing and producing a diverse range of products from raw materials to commodity and specialty chemicals. These products include high-performance materials needed for aerospace, automotive, biomedical, electronic, environmental, and military applications. Chemical engineers work in a variety of industries, including chemical manufacturing, energy, biotechnology, electronics, food, clothing, paper, health care, and business services.

Educational Objectives

The Chemical Engineering Department's educational objectives are to:

1. Prepare student who continue to exhibit and commit to lives of faith in Jesus Christ and service to family, church, and community.
2. Prepare students, through a broad university education, who continue to: develop and demonstrate reasoning skills and effective communication abilities, deepen their understanding of contemporary and global issues, pursue lifelong learning, and expand their involvement toward the improvement of society.
3. Prepare students to develop and implement solutions for a lifetime of open-ended, technical, and other problems by equipping them with a strong foundation in engineering, science, and mathematics and excellent training in chemical engineering theory and practice.
4. Prepare students who exemplify professional ethics, exhibit an appreciation for diversity, work with and contribute to the development of others, and engage in responsible engineering practice.

These objectives are intended to help develop the following attributes in students graduating from the program:

1. An understanding of the chemical engineering major and profession.
2. An understanding of fundamental principles of mathematics and science.
3. An understanding of chemical engineering fundamentals.
4. Practical experience with chemical process equipment, chemical handling, chemical analysis, and process instrumentation.
5. An ability to use modern engineering tools necessary for engineering practice.
6. An ability to define and solve engineering problems.
7. A dedication to and a working knowledge of safety and environmental aspects of engineering practice.

8. An ability to communicate ideas effectively in both oral and written form.
9. An ability to work effectively with others to accomplish common goals.
10. An ability to apply chemical engineering fundamentals to solve open-ended problems and to design process units and systems of process units including multiple operations.
11. An appreciation for and a commitment to ethical and professional responsibilities.
12. An appreciation for and a commitment to the continuing pursuit of excellence and the full realization of human potential.

Career Opportunities

The combination of knowledge about process engineering, math, and chemistry obtained in the chemical engineering curriculum is a versatile preparation that opens a wide variety of opportunities to graduates. This versatility is one reason why chemical engineers have traditionally been among the highest paid professionals in the engineering and science disciplines.

Chemical engineers make a significant difference in the quality of life. Some develop clean, new energy sources to power society. Some develop and produce fertilizers and other agricultural chemicals to feed mankind. Virtually all pharmaceuticals are produced by chemical engineers to enhance the life of millions. Others study and produce biomedical devices and artificial organs. Still others are involved in development and production of new materials for use in new high-tech products.

Chemical engineers produce chemicals ranging in use from cleaning products to medicines and from man-made fibers for clothing and textiles to plastics for construction and consumer goods. Another large employer of chemical engineers is the semiconductor industry. In work that involves significant knowledge of chemistry and related processes, chemical engineers assist in the design and manufacture of semiconductor chips and circuit boards. The petroleum industry also employs chemical engineers, requiring their expertise for the discovery, production, and refining of petro-chemicals, including fuels, chemicals, and oils.

Many chemical engineers are employed in environmentally related positions, working on ways to improve air and water quality, to reduce acid rain and smog, and to recycle and reduce waste. Additionally, chemical engineers are employed by universities as teachers and researchers and by government agencies to provide answers for energy, environmental, and defense concerns. Chemical engineers also train to work in the medical, business, and legal professions.

Though chemical engineering career opportunities are diverse, job functions can be categorized more easily. Chemical engineers are usually involved in research, design, development, production, technical sales, or management.

In research, they develop new ideas, new products, and new ways to produce existing products more economically and with less environmental impact.

In design, they create the processes that convert raw materials into finished products with emphasis on efficiency, safety, consumer needs, and environmental protection.

The development engineer improves existing processes and technology to better meet changing needs.

Production engineering involves supervision, quality control, and testing of production processes and operations.

Management and technical sales involve decision making with regard to consumer needs and technical capabilities.

Chemical engineers are creative problem solvers. Their careers are rewarding not only from an intellectual and financial view, but also from a personal perspective. Affecting the lives of millions, their solutions provide a better lifestyle for mankind.

Graduation Requirements

To receive a BYU bachelor's degree a student must complete, in addition to all requirements for a specific major, the following university requirements:

- The university core, consisting of requirements in general and religious education (See the University Core section of this catalog for details. For a complete listing of courses that meet university core requirements, see the current class schedule.)
- A minimum of 30 credit hours in residence
- A minimum of 120 credit hours
- A cumulative GPA of at least 2.0

Undergraduate Programs and Degrees

BS Chemical Engineering

Students should see the college advisement center (264 CB) for help or information concerning the undergraduate programs.

Graduate Programs and Degrees

MS Chemical Engineering
PhD Chemical Engineering

For more information see the BYU 2007–2008 Graduate Catalog.

General Information

The Chemical Engineering Department offers a professional program leading to the bachelor of science degree. The first two years of this program are considered to be preprofessional with course work emphasis on math, chemistry, and chemical engineering fundamentals. The remaining two years are considered to constitute the professional program.

Any student who is admitted to the university may choose this program as a possible major. All students are urged to declare their intention to major in the department upon first entry to the university or as soon thereafter as possible by contacting the college advisement center (264 CB). Students electing to major in this program must successfully complete the minimum preprofessional program requirements and submit an application for the department's professional program.

Transfer Students. Provisions have been made so that a qualified student transferring from a junior college or from another university, college, or department, who has completed the equivalent of the first two years of the academic program, can complete the BS degree requirements in another two years. Contact the department at the earliest date possible so that any variations can be accommodated with minimum loss of time.

Integrated Master's Program. At the end of the sophomore year or during the junior year, qualified students desiring a master's degree in chemical engineering may elect to enter the integrated master's program. The purpose of this program is to afford greater flexibility in scheduling course work than is normally available through the traditional BS degree followed by MS degree program. In this program students may work toward both the bachelor's and master's degrees simultaneously, either receiving the BS degree before or at the same time as the MS degree. At the end of the sophomore year students must have a cumulative GPA of 3.5 or more. All credit to be counted toward the master's degree must carry a cumulative GPA of 3.0 or better.

Before completing the final 30 hours of undergraduate course work, students should submit a formal application for admission to the Office of Graduate Studies. Additional details may be obtained from the college advisement center.

Professional Registration. The Chemical Engineering Department encourages graduates to become registered professional engineers. General qualifications for becoming registered are explained in the Ira A. Fulton College of Engineering and Technology section of this catalog. Some states require this status for consulting and practice in the private sector. Successful completion of the basic chemical engineering program outline prepares graduates to pass the Fundamentals of Engineering (FE) examination. Students who wish to become registered as professional engineers are also advised to talk to their advisor about developing their own professional engineering option, which may include additional FE preparation courses.

Professional Program Admission Policy. Admission to the professional program is available to all students in good academic standing with the univeristy who have (a) passed the prerequisite courses for the first-semester professional courses, namely Ch En 273 and Math 302, and (b) submitted to the department an Application for the Chemical Engineering Professional Program.

The Application for the Chemical Engineering Professional Program requires students to meet with their department advisor for direction and counseling with regard to performance in the preprofessional program courses and successful completion of the professional program.

Academic Standards and Continuance Policy. The student's academic standing with the university must be "Good" or "Previous" to enroll in professional program courses. Anyone who accumulates chemical engineering grades below C– in excess of 6 hours may not take further chemical engineering courses until he or she has reduced the unacceptable credits to 6 hours or less. A student may not graduate with more than 3 hours below C– in chemical engineering courses.

BS Chemical Engineering (101.5–103.5 hours*)

Major Requirements

1. Students are strongly encouraged to consult with the department about their course scheduling.
2. Complete the following preprofessional courses:
   Chem 111, 112 (or 105, 106, 107).
   Ch En 170, 263, 273, 291.
   Math 112, 113, 302, 303.
   Phscs 121, 220.
3. Complete the following professional courses:
   Ch En 311, 373, 374, 376, 378, 391, 436, 451, 475, 476, 477, 478.
4. Complete the following supporting courses:
   Biol 100.
   Chem 351, 352, 461.
   Econ 110.
   Engl 316.
   Stat 332.
5. Complete technical electives (12 hours minimum) satisfying the following requirements:
   a. Complete 2 hours of chemistry laboratory (Chem 113, 353, 464, or 465).
   b. Complete 6 hours of advanced (300-level or above) engineering course work from any of the following departments: Chemical Engineering, Civil and Environmental Engineering, Electrical and Computer Engineering, Mechanical Engineering, or the School of Technology.
   c. Complete 4 hours of advanced (300-level or above) course work from an engineering, math, science, or business department. Only 1 hour of Chem 497 is acceptable. No more than 3 hours of Ch En 498R (only 2 hours if Chem 497R is taken) may be applied to the program. Phscs 281 is approved for this requirement.
6. Pass a basic competency exam (L3 Exam) administered by the Chemical Engineering Department (see the department for details).

*Hours include courses that may fulfill university core requirements.

Chemical Engineering (Ch En)

Undergraduate Courses

170. Introduction to Chemical Engineering. (2:2:0) F, W Prerequisite: Chem 111 (or 105) or equivalent or concurrent enrollment.
Principles of chemical processes and analyses with spreadsheets and graphics. Applying chemical engineering to current problems.

199R. Academic Internship. (1–3:Arr.:Arr. ea.) F, W, Sp, Su Prerequisite: consent of both department chair and cooperative education coordinator.
Work experience evaluated by supervisor and posted on student's transcript.

263. Computational Tools for Chemical Engineers. (2:2:0) F, Sp Prerequisite: Ch En 170 or concurrent enrollment; Math 113.
Use of spreadsheets, advanced equation-solving packages, and structured languages to solve engineering problems. Introduction to chemical process principles. College Lecture attendance required.

273. Chemical Process Principles. (3:3:0) W, Sp Prerequisite: Ch En 170 or equivalent or concurrent enrollment; Ch En 263 or equivalent; Chem 106 or 112; concurrent enrollment in Phscs 121, Math 113.
Material and energy balances. College Lecture attendance required.

291. Preprofessional Seminar. (0.5:1:0) F, W
Presentations by faculty, advisors, and industrial representatives. College Lecture attendance required.

310. Energy and the Environment. (3:3:0) F Prerequisite: Ch En 273 or equivelent.
Energy sources, demands, and processes; costs and environmental studies; case studies of various fossil fuel and alternate energy sources; introduction to combustion and flames.

311. Chemical Engineering and Society. (3:3:0) F Prerequisite: Ch En 273; admission to professional program.
Responsibility of chemical engineers when interacting with society relative to safety, environment, and ethics.

373. Chemical Engineering Thermodynamics. (3:3:0) W Prerequisite: Ch En 273, 311; Chem 461.
First and second laws of thermodynamics as applied to behavior of real fluids; physical and chemical equilibrium. College Lecture attendance required.

374. Fluid Mechanics. (3:3:0) F Prerequisite: Math 302, Ch En 273; concurrent enrollment in Ch En 311; admission to professional program.
Basic mass, momentum, and energy relations of fluid flow; design of fluid-handling systems and equipment. College Lecture attendance required.

376. Heat and Mass Transfer. (3:3:0) W Prerequisite: Ch En 311, 374.
Heat and mass transfer, including conduction, convection, radiation, diffusion; steady and unsteady state systems; transport analogies; design applications.

378. Science of Engineering Materials. (3:3:0) F, Sp Prerequisite: Chem 351 or instructor's consent.
Fundamental principles of solid materials and their properties and behavior in engineering applications of metals, polymers, ceramics, and glasses.

381. Introduction to Semiconductor Processing. (3:2:1) F Prerequisite: Chem 105 or 111 or equivalent; Math 303 or equivalent; Ch En 273 or instructor's consent.
Unit operations related to silicon-based semiconductor processing, including substrate preparation, photolithography, doping, etching, and thin film formation. Lab included.

391. Career Skills. (1:1:0) F, W Prerequisite: admission to professional program.
Professional, communication, and lifelong learning skills. Field trip to chemical process facility.

400. Creative Skills in Chemical Engineering. (1:1:0) F
Application of creativity and technical knowledge from prior course work to solution of relevant, open-ended problems.

411. Air Pollution Control. (3:3:0) W alt yr. Prerequisite: Ch En 273 or instructor's consent.
Causes and effects of air pollution; standards, criteria, and legislation; dispersion, meteorology, and atmospheric chemistry. Includes design project and use of impact statements.

412. Introductory Nuclear Engineering. (3:3:0) On dem. Prerequisite: Math 303; Chem 106 or 112.
Principles and application of nuclear reactor design.

436. Process Control and Dynamics. (3:3:0) F Prerequisite: Math 303, Ch En 376, 478.
Process systems, associated control systems, and instrumentation. Use of Laplace transforms and complex variables.

451. Chemical Engineering Plant Design and Process Synthesis. (4:4:0) W Prerequisite: Ch En 391, 436, 476, 478.
Design of chemical engineering machinery; plants and/or processes requiring application of unit operations; chemical process principles; economic analysis. Synthesis and optimization of chemical processes. College Lecture attendance required.

475. Unit Operations Laboratory 1. (2:1:6) F, Sp Prerequisite: Ch En 374, 376, 391; Engl 316; Stat 332.
Experimental verification of unit operations design principles; data collection and reduction; report preparation.

476. Separations. (3:3:0) F Prerequisite: Ch En 373, 376.
Stage operations, distillation, extraction, and absorption; design applications. College Lecture attendance required.

477. Unit Operations Laboratory 2. (2:1:6) W, Sp Prerequisite: Ch En 476, 478. Recommended: Ch En 391, 476, 478; Engl 316; Stat 332.
Experimental verification of unit operations design principles; data collection and reduction; report preparation.

478. Chemical Reaction Engineering. (3:3:0) W Prerequisite: Ch En 311, Chem 461.
Fundamental principles and equations of chemical kinetics and reactor design.

493R. Special Topics—Undergraduate. (1–3:3:Arr. ea.) Prerequisite: instructor's consent.
Classroom study based on student and faculty interest.

498R. Undergraduate Research. (1–3:Arr.:Arr. ea.) F, W, Sp, Su Prerequisite: faculty committee approval.
Final report required; 2 hours maximum allowed for degree credit.

500-Level Graduate Courses (available to advanced undergraduates)

518. Biomedical Engineering Principles. (3:3:0) W Prerequisite: Ch En 374, 376, 478; or equivalents.
Application of chemical engineering principles to model physiologic systems and to solve medical problems.

528. Industrial Catalytic Processes. (2:2:0) Sp alt. yr. on dem. Prerequisite: Chem 106 or 111; 351; Ch En 378, 478; or equivalents.
Fundamentals of catalytic chemistry and materials; applications to important industrial catalytic processes. Includes catalyst materials and preparation, catalyst characterization, fixed-bed reactor design, and catalyst deactivation.

531. Thermodynamics of Multicomponent Systems. (3:3:0) F Prerequisite: Ch En 373 or Chem 461 or equivalent.
Fundamental concepts and applications in first and second laws, equilibrium and stability, phase equilibrium, and homogeneous and heterogeneous chemical equilibrium.

533. Transport Phenomena. (3:3:0) F Prerequisite: Ch En 476 or equivalent or concurrent enrollment. Recommended: Math 347 or equivalent.
Transport mechanisms and coefficients and fundamental field equations for momentum, heat, and mass transport, with application to system design.

535. Kinetics and Catalysis. (3:3:0) F Prerequisite: Ch En 478 or equivalent.
Theories and principles of chemical kinetics, including heterogeneous catalysis and reactor design.

541. Computer Design Methods. (3:3:0) Alt. yr. Prerequisite: Math 311, Ch En 376; or equivalents.
Computer-aided design and numerical methods of chemical engineering processes.

578. Polymer Science and Engineering. (3:3:0) W even yr., Sp odd yr. Prerequisite: Ch En 373, 374, 378, 478; or equivalents.
Foundation science and theory of polymer chemistry and physics and their implications in engineering applications. Topics include polymerization chemistry, structure-property relationships, polymer physics, and transport properties.

593R. Special Topics—Intermediate. (1–3:Arr.:Arr. ea.) On dem. Prerequisite: instructor's consent.
Special topics for advanced undergraduate students and for graduate students.

Graduate Courses

For 600- and 700-level courses, see the BYU 2007–2008 Graduate Catalog.

Chemical Engineering Faculty

Professors

Bartholomew, Calvin H. (1973) BES, Brigham Young U., 1968; MS, PhD, Stanford U., 1970, 1972.
Baxter, Larry L. (2000) BS, PhD, Brigham Young U., 1983, 1989.
Fletcher, Thomas H. (1991) BS, MS, PhD, Brigham Young U., 1979, 1980, 1983.
Harb, John N. (1988) BS, Brigham Young U., 1983; PhD, U. of Illinois, 1988.
Lewis, Randy S. (2005) BS, Brigham Young U., 1989; PhD, MIT, 1995.
Oscarson, John L. (1974) BES, Brigham Young U., 1968; MS, PhD, U. of Michigan, 1972, 1985.
Pitt, William G. (1987) BS, Brigham Young U., 1983; PhD, U. of Wisconsin, Madison, 1987.
Rowley, Richard L. (1984) BS, Brigham Young U., 1974; PhD, Michigan State U., 1978.
Solen, Kenneth A. (1976) BS, U. of California, Berkeley, 1968; MS, PhD, U. of Wisconsin, Madison, 1972, 1974.
Terry, Ronald E. (1987) BS, Oregon State U., 1971; PhD, Brigham Young U., 1976.
Wilding, W. Vincent (1994) BS, Brigham Young U., 1981; PhD, Rice U., 1985.

Associate Professor

Hecker, William C. (1982) BS, MS, Brigham Young U., 1974, 1975; PhD, U. of California, Berkeley, 1982.

Assistant Professors

Knotts, Thomas A., IV (2006) BS, Brigham Young U., 2001; PhD, U. of Wisconsin, Madison, 2006.
Wheeler, Dean R. (2002) BS, Brigham Young U., 1996; PhD, U. of California, Berkeley, 2002.

Emeriti

Barker, Dee H. (1959) BS, PhD, U. of Utah, 1948, 1951.
Beckstead, Merrill W. (1977) BS, PhD, U. of Utah, 1961, 1965.

Hanks, Richard W. (1963) BES, Yale U., 1957; PhD, U. of Utah, 1960.
Hedman, Paul O. (1977) BS, U. of Utah, 1957; PhD, Brigham Young U., 1973.
Pope, Bill J. (1958) BS, U. of Utah, 1947; MS, PhD, U. of Washington, 1948, 1959.
Smoot, L. Douglas (1967) BS, BES, Brigham Young U., 1957, 1957; MS, PhD, U. of Washington, 1958, 1960.

Chemistry and Biochemistry

Paul B. Farnsworth, Chair
C-104 BNSN, (801) 422-6502

College of Physical and Mathematical Sciences Advisement Center
N-179 ESC, (801) 422-6270

Admission to Degree Program

All degree programs in the Department of Chemistry and Biochemistry are open enrollment. However, special limitations apply for teaching majors.

The Discipline

Chemistry is the study of matter, the changes undergone by matter, and the laws that govern the changes. Chemists study atoms as well as the structures and reactions of molecules. They also work to develop simplifying models (theories) that permit the correlation and explanation of observations about matter. Chemical principles are fundamental to the understanding of subjects ranging from the molecular basis of biology to the structure of rocks and minerals. Chemistry is an essential foundation in engineering disciplines, especially in chemical engineering, electronics, energy and environmental science, geology, pharmacy and medicine, and in virtually all manufacturing areas.

Chemistry is an active science that is vital to human existence. Energy needs, environmental concerns, and requirements for new materials all involve major contributions from chemists. Examples of the diverse areas of interest to chemists include regulation of protein synthesis, signal transduction at the cellular level and proteomics (biochemistry), design and synthesis of medicinal compounds (organic chemistry), design and synthesis of new molecular structures and materials (inorganic chemistry), spectroscopic study of energy transfer and molecular structures (physical chemistry), and analysis of medicinal compounds, biological materials, and contaminants or trace elements found in the environment (analytical chemistry).

Chemistry involves more than test tubes and beakers. It includes working with a variety of equipment and instruments such as mass spectrometers, calorimeters, chromatographs, ultracentrifuges, lasers, X-ray diffractometers, and nuclear magnetic resonance spectrometers.

Career Opportunities

Graduates in chemistry obtain positions in virtually every industry, and those who have imagination and intellectual curiosity are in particular demand. Chemistry is also an excellent preprofessional course of study for those interested in medicine, dentistry, law, and business. The chemistry curriculum is both rigorous and intellectually rewarding.

Graduation Requirements

To receive a BYU bachelor's degree a student must complete, in addition to all requirements for a specific major, the following university requirements:

- The university core, consisting of requirements in general and religious education (See the University Core section of this catalog for details. For a complete listing of courses that meet university core requirements, see the current class schedule.)
- A minimum of 30 credit hours in residence
- A minimum of 120 credit hours
- A cumulative GPA of at least 2.0