Chemical Engineering, BSE

The major in chemical engineering provides a broad education at the leading edge of technology. It emphasizes fundamental concepts, problem solving, laboratory techniques, and communication skills. The biological sciences join physics, chemistry, and mathematics as foundation disciplines for chemical engineering.

The sophomore, junior, and senior years emphasize chemical engineering courses such as materials and energy balances, computational tools for chemical engineers, fluid flow, chemical engineering thermodynamics, heat and mass transfer, separations, chemical reaction engineering, chemical process safety, biochemical engineering, process dynamics and control, and process design. Experience in instrumentation, analysis, and design is obtained through an integrated laboratory program. Routine use is made of computer-based data analysis, simulation, and design.

Focus Areas

Chemical engineering students may gain a depth of knowledge related to a career path through their selection of science, engineering, and general education courses. Several preapproved focus areas may help students define potential careers; the focus area enables students to gain depth of knowledge in a career path. Students meet with their chemical engineering academic advisor to discuss career options and develop a plan for choosing electives based on their career interests. The department offers preapproved focus areas in biochemical engineering; business; chemical process engineering; computation, data science, and machine learning; energy and environment; entrepreneurship; oil and gas engineering; pharmaceuticals; polymers; pre-medicine; safety and health; and sustainability. Students may prefer to develop an individualized focus area, which is subject to approval by the department's curriculum committee.

Biochemical Engineering

This focus area allows students to choose from a selection of courses that combine concepts of biology, biochemistry, and engineering. Biochemical engineers combine knowledge of these three areas to manufacture products of biological nature, including fermentation products and pharmaceuticals. Students often go on to work in the biotechnology and pharmaceutical industries as production leaders or researchers.

Business

This focus area consists of eight courses from the Tippie College of Business. Students gain foundational business knowledge on topics including finance, economics, accounting, marketing, law, and management. Past students have applied their integrated business and technical knowledge to many different settings including manufacturing plants, consulting, and corporate offices.

Chemical Process Engineering

Process engineering is the design, optimization, and operation of systems that transform raw materials into valuable products. Process engineers are involved with products, including foods and beverages, electronic materials, metals, plastics, fuels, building materials, and pharmaceutics. Since chemical process engineering spans many aspects of engineering, business, applied math, and science, students can choose from a broad selection of engineering, math, and science courses. This focus area provides ample room for customization and opportunities to tailor to individualized interests.

Computation, Data Science, and Machine Learning

This focus area is for students who intend to blend advanced computation and programming with their chemical engineering degree. This area is customizable based on student interest areas and can accommodate introductory training in cyber-physical systems, remote sensing, advanced simulation, supply chain management, in silico chemistry and biology, bioinformatics, software design, next-generation controls, machine learning, and artificial intelligence.

Energy and Environment

Students who are passionate about the environment should consider this focus area. Courses prepare students to solve environmental challenges and to revolutionize energy systems. Topics include air pollution, climate change, clean and renewable energy, environmental regulations, and sustainable systems.

Entrepreneurship

This focus area allows students to focus on the process of succeeding in the world of startups, innovation, business ownership, and new products. The area is well-suited for students who intend to start and operate their own business. It also serves students interested in gaining a better understanding of managing innovation in an existing business environment. The wide range of electives permits students to tailor business courses best suited to their individual interests.

Oil and Gas Engineering

Meant for students interested in pursuing careers in oil and gas engineering, this focus area explores foundational elements of chemistry, geology, petrochemical refining, and environmental science. The course plan offers several recommendations put in place by experienced advisors with petrochemical backgrounds. Often viewed as the birth of chemical engineering, the petroleum industry provides a host of challenging and lucrative opportunities for chemical engineers. This path provides a unique and focused introduction to the field.

Pharmaceuticals

Chemical and biochemical engineering is central to the design, formulation, and manufacturing of pharmaceutical products. Students who are passionate about medical applications can align their chemical engineering skills toward a career in pharmaceuticals by choosing this focus area. The curriculum features biology, drug delivery, and the mechanisms and chemistry of drug interactions. Course options span many departments besides chemical and biochemical engineering, including biomedical engineering, biochemistry and molecular biology, pharmacy, and pharmacology.

Polymers

This focus area enables students to study the development of chemical compounds by polymerization, including combining small molecules into engineered networks to produce valuable plastics and other advanced materials. The program is well

suited for students who intend to use their knowledge to design new materials; it also serves students interested in gaining a better understanding of the links between molecular scale structure and macroscopic scale properties.

Pre-Medicine

Concepts of chemical engineering are naturally applicable to the processes in living organisms. This focus area enables students to apply these concepts to gain a deeper understanding of the atoms and molecules that comprise living organisms, and the pathways through which they operate. This program is for students who intend to use their knowledge to gain acceptance to post-graduate education in the medical field.

Safety and Health

This focus area prepares students to prevent incidents and accidents in chemical and pharmaceutical manufacturing, particularly those resulting from the unintentional release of hazardous materials and energy into the environment; and provide a safe and healthy workplace by preventing injuries and hazards in the workplace environment.

Sustainability

This focus area covers the most important and current topics in environmental science, societal impacts, energy usage, and natural systems. Courses prepare students to understand and discuss these topics as they relate to chemical engineering.

Educational Objectives

The chemical engineering program produces graduates with a strong foundation of scientific and technical knowledge who are equipped with problem-solving, teamwork, and communication skills that will serve them throughout their careers consistent with the following educational objectives. Within a few years following graduation, graduates will:

- attain careers as practicing chemical engineers in fields such as biotechnology, chemicals, computation, energy, environmental engineering, food processing, microelectronics, pharmaceuticals, or polymers/advanced materials;
- pursue advanced studies in disciplines such as business, chemical engineering, dentistry, environmental engineering, law, medicine, or pharmaceuticals; or
- assume professional leadership roles.

The following methods and strategies are used in the chemical engineering undergraduate program to achieve these program educational objectives:

- foster a unique and personalized undergraduate experience by leveraging the advantages of a small college atmosphere within a comprehensive liberal arts and research university;
- provide a diverse, inclusive, and equitable environment for all students;
- enrich the undergraduate experience through cultural diversity, international opportunities, and/or experiential learning;
- provide a solid foundation and understanding of the fundamental principles of mathematics, science, and engineering;
- provide students with experience in learning and applying tools, and analyzing and interpreting data, to solve theoretical and open-ended chemical engineering problems;
- provide students with opportunities to participate in collaborative teams;
- develop students' written and oral communication skills to a wide range of audiences;
- provide students with opportunities to design and conduct chemical engineering experiments and to design systems, components, and chemical processes to meet specific needs and constraints;
- provide a contemporary grounding in ethical and professional responsibility, including global, economic, environmental, safety, and societal impacts of engineering decisions; and
- instill the desire and the understanding of the need for lifelong learning.