Chemical and Biochemical Engineering

Chair

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Undergraduate major: chemical engineering (BSE)

Graduate degrees: MS in chemical and biochemical engineering; PhD in chemical and biochemical engineering

Faculty: https://engineering.uiowa.edu/cbe/people

Website: https://engineering.uiowa.edu/cbe

Facilities

Chemical engineers at the University of Iowa, whether undergraduates or graduate students, benefit from the extensive resources of a top research university. Some of the key facilities and resources available to them include libraries, computing centers, machine and electronics shops, a tool library, prototyping and design studios, chemical analysis and microscopy resources, genetic, cell, and tissue analysis facilities, tutoring and writing centers, and other specialized research infrastructure. These resources are utilized according to each student's customized curriculum and research needs, ensuring they get the most out of their education and training. Specific laboratories maintained by the Department of Chemical and Biochemical Engineering to support undergraduate courses are listed as follows.

Chemical Engineering Laboratory

The Chemical Engineering Laboratory provides hands-on learning for students in CBE:3150 Thermodynamics/Transport Laboratory and CBE:3155 Chemical Reaction Engineering/ Separations Laboratory. The lab features transparent equipment—including a distillation column, heat exchangers (plate, shell-and-tube, concentric tube), and a wiped film evaporator—allowing students to observe processes in real time. Additional equipment includes a jacketed kettle, packed bed reactor, fluid friction apparatus, and membrane gas separator. Students also use advanced portable analytical devices such as densitometers, polarimeters, and refractometers for chemical analysis. A wide range of small-scale equipment supports course projects, independent investigations, and student teams competing in national chemical engineering competitions. This laboratory equips students with the problem-solving skills and technical expertise needed for success in chemical engineering careers.

Chemical Process Safety Laboratory

Central to CBE:3125 Chemical Process Safety, this laboratory provides students with a deep understanding of the principles and practices that ensure safe chemical operations. Through a series of interactive experiments, students explore flammability limits, chemical reactivity, explosion hazards, electrostatic discharge, and relief system design—all critical for industrial safety. The lab is equipped with advanced instrumentation, including MiniFlash automatic flash point testers, an Advanced Reactive System Screening Tool (ARSST) for thermal stability analysis, and a Minimum Ignition Energy (MIE) apparatus for assessing ignition risks. Students also work with a flammability chamber, modified Hartmann tube and Hartmann bomb for dust explosion studies, and specialized devices for measuring liquid conductivity, powder chargeability, and volume resistivity. Additional resources include a Van de Graaff generator, high-impedance electrometers, a Faraday cage, and relief sizing software. These hands-on experiences prepare students to identify hazards, evaluate risks, and design safer processes—skills essential for careers in chemical engineering.

Biochemical Engineering Laboratory

Supporting CBE:3205 Introduction to Biochemical Engineering, this laboratory immerses students in the fundamentals of biotechnology and bioprocessing. Students conduct experiments involving recombinant DNA techniques, microbial growth kinetics, and metabolic analysis to understand how biological systems are engineered for industrial applications. The lab features two controlled New Brunswick BioFlo/CelliGen 115 bioreactors, enabling precise control of environmental conditions for fermentation and cell culture studies. Additional equipment includes electrophoresis apparatus for protein and nucleic acid separation and a thermocycler for polymerase chain reaction (PCR) experiments. These tools allow students to explore applications in pharmaceuticals, biofuels, and food processing, while gaining practical experience in scaling up biological processes—a critical skill for careers in biochemical and biopharmaceutical industries.

Process Control Laboratory

Used in CBE:4105 Process Dynamics and Control in Design and CBE:5199 Contemporary Topics: Chemical and Biochemical Engineering, this lab provides industrial-grade computer-controlled systems for managing flow, level, composition, and temperature in pilot-scale devices. Students gain experience with DeltaV and LabVIEW, learning control strategies, SCADA systems, dynamic modeling, and hardware-software integration. Advanced modules guide students through the full design cycle—programming, hardware integration, and troubleshooting—preparing them for real-world process automation. These experiences are essential for modern chemical plant operation.

Materials Science Laboratory

The Materials Science Laboratory supports ENGR:2720 Materials Science, giving students hands-on experience with the mechanical and structural properties of materials. The lab includes tensiometers, hardness testers, an Izod impact tester, a contact angle goniometer, and heat treatment/ sintering furnaces for material characterization. Students also work with optical microscopes, metallography specimen kits, and crystallography packages to explore how material properties relate to structure. Additionally, the lab features a desktop injection molding machine, providing practical insight into polymer processing and manufacturing techniques. By exploring material properties and manufacturing techniques, students gain practical skills for careers in advanced materials and product design.

Graduate Facilities and Laboratories

The department offers a wide variety of facilities to support and develop research activities.

Air Quality, Climate, Remote Sensing, and Smart Sensing Research Thrusts

The department maintains extensive facilities for computational, field, and laboratory studies of air pollution in the context of climate change. Part of this infrastructure is housed at the Center for Global and Regional Environmental Research (CGRER). The center occupies 5,000 square feet of lab and office space on the fourth floor of the Iowa Advanced Technology Laboratories. CGRER members have dedicated queues and storage within the University of Iowa's extensive High Performance Computing (HPC) facility.

Individual professors maintain a wide variety of air pollution sampling equipment, with a focus on both aerosol and gas-phase physics and chemistry in the context of climate, weather, and human health.

The Atmospheric and Environmental Research (AER) Lab has a diverse research portfolio that encompasses three research themes: development of remote sensing theory and algorithms for characterizing atmospheric (aerosol) particles and surface emissions (especially from fires); development and application of chemistry-aware atmospheric models and observation data to studies in air quality, weather, and climate; and interdisciplinary research via collaborative teamwork in such areas as air quality and public health, irrigation and climate change, environmental monitoring and solutions via community science and engagement.

The Iowa Atmospheric Sensor Development Laboratory (IASDL) is a fully equipped research laboratory dedicated to developing new remote sensing instruments to study the Earth's atmosphere. Focused on laser-based, or lidar, remote sensing, researchers in IASDL develop sensors for use in ground-based, airborne, and spaceborne applications. Advanced technologies and onboard machine learning processing are the basis for creating affordable sensors that produce real-time data products to impact air quality, human health, and decision-making. Researchers in IASDL frequently work with the Operator Performance Laboratory, which is home to several research aircraft, and collaborate with researchers at NASA and other organizations.

Biochemical Engineering

Biochemical engineering laboratories provide facilities for the preparation of biological media and the cultivation of organisms, as well as for the separation and analysis of biomolecules. This equipment includes biological incubators and floor incubator shakers, agitated and airlift bioreactors, light microscopes, autoclaves, thermocycler for polymerase chain reaction (PCR) amplification of DNA, centrifuges, UV-Vis spectrophotometers, a lyophilizer, biological safety cabinets, and an anaerobic glove box. Epifluorescence microscopes, gel electrophoresis systems, and high-performance liquid chromatography systems are available for the characterization of microorganisms and constituent biomolecules.

Through collaborative research agreements, graduate students also have access to specialized facilities for electron microscopy, large-scale fermentation, protein structure, recombinant DNA research, and tissue culture/hybridoma; the Flow Cytometry Facility; and the High Resolution Mass Spectrometry Facility.

Biomedical Engineering

The biomedical engineering laboratories house equipment for the preparation of biomaterials development and thermal treatments, including sonicators, diffusion cells, electroresistive and thermoelectric hypothermia systems, zetapotentiometer, DNA preparation equipment, gel electrophoresis apparatus, UV-Vis/fluorescent plate reader, fluorimeter with thermal sample control, high performance liquid chromatograph, luminometer, lyophilizer, alternating magnetic field generators, microscopes, incubators, wet chemistry equipment, rotary shakers, incubated plate shakers, autoclave, centrifuges, and laboratory computers.

Graduate students also have access to core research facilities, including the Central Microscopy Research Facility, Flow Cytometry Facility, Iowa Institute of Human Genetics, Animal Resource Facility, Electron Spin Resonance Facility, Nuclear Magnetic Resonance Facility, High Resolution Mass Spectrometry Facility, and the Center for Gene Therapy.

Computer Facilities

The departmental computer facilities contain a variety of laptops, desktop workstations, and printers. The department is supported by the college's Engineering Technology Center, which maintains a large network of high-performance Linux and Windows workstations along with extensive commercial and public domain software. The department has access to the university's central high-performance research computing facility through ITS–Research Services. The University of Iowa also has access to the ACCESS and Blue Waters national supercomputing resources and is a founding member of the Great Lakes Consortium for Petascale Computing. Locally hosted long-term data storage services are available.

Fundamentals and Applications of Photopolymerization

The Photopolymerization Center was established to advance a fundamental understanding of the kinetics and mechanisms of photopolymerizations. To this end, the center provides unique opportunities for collaborations by industrial and academic investigators to explore photopolymerization processes and develop novel applications based on photopolymerizations.

The center provides equipment and instrumentation for the characterization of photopolymerization systems on the molecular, microscopic, and macroscopic levels. Center researchers pursue an understanding of fundamental photophysical and photochemical processes involved in the photoinitiation reaction, characterization of high-speed propagation and termination kinetics that lead to the polymer structure, and evaluation of material properties through the course of the photopolymerization reaction. Both radical and cationic photopolymerizations are studied with state-of-the-art experimental techniques to elucidate the complex chemical and physical mechanisms that control the initiation, propagation, and termination of the active centers.

Machine Learning and Artificial Intelligence Resources

In addition to specialized software developed and maintained by researchers in the Chemical and Biochemical Engineering department, students, staff, and faculty also make use of the university's High Performance Computing (HPC) resources and the Iowa Institute for Artificial Intelligence (IIAI). HPC

resources include GPU processors that are particularly useful for running machine learning algorithms. The Iowa Institute for Artificial Intelligence helps department researchers transform ideas for machine learning and artificial intelligence applications from concepts to working code.

Electrochemical Engineering

The electrochemical engineering laboratories house facilities for electrocatalyst synthesis and characterization, located in the Iowa Advanced Technology Laboratories (IATL). The equipment includes muffle furnaces and tube furnaces for materials synthesis, optical microscopes for surface characterization, rotating disk electrode (RDE) and rotating ring-disk electrode (RRDE) systems with rotators for electrochemical measurements, flow cells and electrolyzers for device testing, potentiostats/galvanostats (electrochemical workstations), and scanning electrochemical microscope (SECM) for local electrochemical analysis. Three-dimensional printers are available for fabricating customized equipment components and accessories for fluid handling and control. Graduate students also have access to core research facilities, including the Central Microscopy Research Facility, and MATFab Facility.