Chemical and Biochemical Engineering

Interim Chair
- Jun Wang

Undergraduate major: chemical engineering (B.S.E.)
Graduate degrees: M.S. in chemical and biochemical engineering; Ph.D. in chemical and biochemical engineering
Faculty: https://engineering.uiowa.edu/people/cbe-people
Website: https://cbe.engineering.uiowa.edu/

Facilities

Undergraduate Core

Materials Science Laboratory
The Materials Science Laboratory is equipped with optical microscopes and facilities for metallographic preparation. Mechanical tensile testing instruments, heat treatment and sintering furnaces, and hardness testing machines also are available. Teaching aids include metallography specimen kits and crystallography packages.

Required Undergraduate Laboratories

Chemical Engineering Laboratory
The Chemical Engineering Laboratory provides instruction for undergraduate students in CBE:3150 Thermodynamics/Transport Laboratory and CBE:3155 Chemical Reaction Engineering/Separations Laboratory. It is equipped for experimentation in thermodynamics, fluid flow, heat transfer, mass transfer, chemical reaction engineering, and separations. The lab includes pilot plant equipment, such as a distillation column, wiped film evaporator, shell-and-tube heat exchanger, and jacketed kettle. Other equipment includes a double-pipe heat exchanger, membrane gas separator, fluid friction apparatus, and heat conduction apparatus. Analytical equipment includes a densitometer, polarimeters, and refractometers.

The lab is continuously updated to reflect advances at the forefront of chemical engineering technology. Additionally, a wide array of small equipment is available to support laboratory projects and demonstrations in chemical engineering courses and for use by students performing independent investigations.

Chemical Process Safety Laboratory
The Chemical Process Safety Laboratory is an integral part of CBE:3125 Chemical Process Safety. It is equipped with two MiniFlash automatic flash point testers (closed cap), an advanced reactive system screening tool (ARSST), a minimum ignition energy (MIE) apparatus, a flammability chamber, a modified Hartmann tube, a Hartmann bomb, a liquid conductivity apparatus, a powder changeability apparatus, a powder volume resistivity apparatus, a Van de Graaff generator, two high impedance electrometers, a field meter, a Faraday cage, and relief sizing software. This equipment is used in a series of experiments to demonstrate the principles of flammability, reactivity, explosions, relief valve sizing, and electrostatics relevant to industry.

Biochemical Engineering Laboratory
The Biochemical Engineering Laboratory is an integral part of CBE:3205 Introduction to Biochemical Engineering. It is equipped with two controlled New Brunswick BioFlo CelliGen 115 bioreactors, electrophoresis apparatus, and a thermocycler. This equipment is used for recombinant DNA experiments and to study the growth and metabolism of microorganisms.

Process Control Laboratory
The Process Control Laboratory is a modern, computer-based instructional laboratory that is integral to CBE:4105 Process Dynamics and Control in Design. The lab consists of computer control of a shell-and-tube heat exchanger and a level-and-flow control process rig with state-of-the-art industrial control interfaces.

The Computer Control Laboratory offers an ensemble of learning experiences with the same equipment. Additional laboratories provide instruction in the use of process simulators that provide analogies and better insight into the control process. Topics include determination of the gain and time constants for single-capacitance systems; determination of gain, time constant, and damping factor of second-order processes; determination of open-loop and closed-loop response to step-and-ramp changes in input for single-capacitance and multicapacitance processes; approximations of multicapacitance systems as first- and second-order processes with dead time; analysis of instrumentation characteristics and transfer functions; tuning and optimization of feedback control parameters (P, PI, PID); system identification through frequency response methods; and determination of system stability.

Experimental arrangements in the lab are simple enough in design to be easily understood, yet complicated enough to help students appreciate system characteristics inherent in industrial processes (e.g., large time lags, error in parameter estimation).

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

Air Pollution Computational, Field, and Laboratory Studies
The department maintains extensive facilities for computational, field, and laboratory studies of air pollution, carbon cycle gases, aerosols, and nanoparticles 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 houses one R2 ImmersaDesk Portable Large Scale Visualization System and is linked on campus to two more R2 ImmersaDesk units.

The center’s computer laboratory for environmental and spatial data analysis provides numerous Windows and UNIX workstations, sophisticated software packages, and workstations and a file server necessary to run intensive visualization programs. The network backbone is University
supported with high-speed wireless throughout. A variety of
digital environmental databases and an extensive library of
documentation and related references are available. There
are 4 Beowulf Linux clusters on site and Linux clusters of
4, 16, 18, and 20 nodes for large computations and data
assimilation. CGRER retains 15 TB of redundant storage and
50 TB of total storage; local storage space is scalable and
expandable. A variety of software packages and programming
languages are available for data analysis and display,
including ArcInfo, ArcView, NCAR Graphics, MATLAB, S-PLUS,
and Vis5D, as well as geographical information software. The
Esri software suite is part of a University-wide site license.

Laboratory and field equipment includes aerosol samplers,
including scanning mobility particle sizers for aerosols from
3 nanometer to 1 micron with time resolution to 30 seconds;
aerosol particle sizers for aerodynamic measurements of in
situ particles with time resolution to 1 second; and varied
condensation particle counters for measuring total particle
counts. Several hygroscopic tandem differential mobility
analyzers are used, as well as varied aerosol generation
devices and unique aerosol inlets for relative humidity (RH)
and temperature modification and control. Cloud droplet
number can be measured in the lab or in the field using a
Droplet Measurement Technologies cloud condensation
nuclei detector. Advanced computer control of instruments is
available through LabVIEW.

Selected instruments are field deployable in a custom air-
conditioned trailer. Through collaboration with the IHR—
Hydroscience & Engineering, access to micrometeorology
sensors, 1D and 2D elastic and Raman lidar, and gas sensors
is available, including multichannel ammonia monitors.

**Biochemical Engineering**

Biochemical engineering laboratories provide facilities for
preparation of biological media and cultivation of organisms
as well as for separation and analysis of biomolecules. This
equipment includes biological incubators and floor incubator
shakers, agitated and airlift bioreactors, light microscopes,
autoclaves, Vi-Cell cell counter, thermocycler for polymerase
chain reaction (PCR) amplification of DNA, high- and low-
speed centrifuges, UV-Vis spectrophotometers, a lyophlizer,
biological safety cabinets, and an anaerobic glove box. Phase-
contrast and epifluorescence microscopes, gel electrophoresis
systems, gas chromatography units with flame ionization and
electron capture detectors, and several high performance
liquid chromatography systems with refractive index and
photodiode array detectors are available for 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 particle
technology equipment including microemulsion equipment
for drug encapsulation, sonicators, benchtop scale spray
dryers, laser diffraction particle sizer, zetapotentiometer;
DNA preparation equipment, gel electrophoresis apparatus;
interfacial stress rheometer, surface tensiometer, UV-
Vis/fluorescent plate reader, high performance liquid
chromatograph, luminometer, lyophlizer, custom-built
simulated cough machine, microscopes, incubators, wet
chemistry equipment, rotary shakers, incubated plate shakers,
autoclave, centrifuges, and laboratory computers. Cell culture
and bacterial culture facilities are housed adjacent to the
laboratories.

Graduate students also have access to core research facilities
including the Central Microscopy Research Facility, Flow
Cytometry Facility, Iowa Institute of Human Genetics, 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 graphics workstations, printers, and microcomputers.
The department is supported by the college’s Engineering
Technology Center, which maintains a large network of
high performance UNIX and Windows XP workstations along
with extensive commercial and public domain software.
The department also has access to the University’s central
research facility in high-speed vector computation. This
facility has SGI Power Challenge mini-supercomputers
and provides nodes for external links for access to
supercomputers.

**Fundamentals and Applications of Photopolymerization**

The Photopolymerizations Center was established to advance
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 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.