CHEMICAL ENGINEERING

Departmental Facilities

The Chemical Engineering department is based in Dupuis Hall, which is a multi-purpose facility with extensive research laboratories, and large-and small-group teaching classrooms. Department researchers in the bioengineering and bioremediation fields also have laboratory facilities in the multi-disciplinary Biosciences complex, Nicole Hall, and in the Centre for Health Innovation at Kingston General Hospital. We are a medium-sized department, with sufficient size to ensure a breadth of research activities, yet small enough to foster a cohesive learning environment. Research serials and books are housed in the Engineering and Science Library, and a variety of search and document delivery facilities are available on-line. Research is being conducted in the fields of materials and interfaces, bioengineering, sustainable energy sources, and data analytics, optimization and control. Facilities within the polymer and reaction engineering field include a variety of bench and pilot scale polymerization reactors (gas-phase polyolefin, solution and emulsion free-radical, living-radical and condensation polymer systems), polymer processing equipment (twin-screw extruder, Haake internal mixer), rotational and capillary rheometers, fuel cell equipment, and the biomedical research facilities include cell and tissue culture labs. The Chemical Engineering Analytical Facility (ChEAF) was established for the measurement of polymeric physical, thermal and structural properties, and is supported by the Senior Research Engineer. Physical measurements and chemical analyses are carried out using a variety of instruments such as gas chromatographs, elemental analyzer, HPLCs, gel permeation chromatographs, BET surface area analyzer, capillary hydro-dynamic fractionation submicron particle size analyzer, spectrophotometers, IR, FTIR, GC mass spectroscopy, and also by means of novel probes based in light scattering, absorption and fluorescence. Research computations are conducted using a wide range of symbolic computation, numerical analysis, statistical analysis and process simulation software. The research laboratories are supported by two departmental laboratory technologists while the computing facilities are supported by the Faculty of Engineering and Applied Science Information Technology Group.

Researchers in the department are affiliated with the Centre for Health and Innovation (https://www.queensu.ca/hmrc/), the Dunin-Deshpande Innovation Centre (https://www.queensu.ca/innovationcentre/ (https://www.queensu.ca/innovationcentre/)), and the Beaty Water Research Centre (https://waterresearchcentre.ca/ (https://waterresearchcentre.ca/)).

Financial Support

The Department of Chemical Engineering endeavours as much as possible to ensure that every full-time graduate student engaged in research has adequate financial support during his or her graduate program. This support may come from several sources, either individually or in combination with National or Provincial scholarships, Queen's University scholarships and awards, research fellowships provided by faculty researchers, and Departmental teaching assistantships. The minimum level of financial support is presently $25,000 per year for both Master's and Doctoral students. Students who are National Scholarship winners can expect overall financial support that is competitive with that provided by any Chemical Engineering department in Canada.

Fields of Research

The fields of research in the department are Biochemical Engineering, Polymers and Reaction Engineering, and Process Systems Engineering. Within these broad areas, the department has significant research activity in the following areas:

- **Biochemical Engineering:** Biological conversion of biological feedstocks to energy, materials and useful ends (e.g., degradation of pollutants). Feedstocks may be virgin sourced or may be waste material such as agricultural waste. Separation of products is also studied including the use of phase partitioning bioreactors to combine bioreaction and separation. Researchers: Andrew Daugulis, Juliana Ramsay, Bruce Ramsay and Pascale Champagne.
- **Environmental Engineering:** Biological conversion of pollutants to benign products using fermenters or in situ processing of contaminated soils. Work is also underway examining turbulent dispersion in the environment, primarily for air quality. Researchers: Juliana Ramsay, Bruce Ramsay and Andrew Daugulis.
- **Macro-molecular Processes and Products:** Polymer & reaction engineering with a broader title to include biological macro-molecules as well. The department has a particularly strong research concentration in this area, with one of the largest polymer engineering groups in North America and elsewhere internationally. The research expertise spans the entire range of polymer engineering, from polymer reaction chemistry, to polymer reaction engineering, to processing and compounding. Expertise in biopolymers and biomaterials includes hydrogels, scaffold material for tissue regeneration, encapsulation of bioactive materials, polyurethanes

for biomedical application and polymer gel dosimetry. Researchers: Brian Amsden, Michael Cunningham, A. Jeffrey Giacomin, Robin Hutchinson, Marianna Kontopoulou, Kim McAuley, Scott Parent, and Kim Woodhouse.

- **Biomedical Engineering:** Tissue engineering including scaffolds for adipose and muscle tissue regeneration, mechanical stimulation to promote regeneration, interaction between surfaces and cells in regeneration, oral delivery of insulin and polymer gel dosimeters. Researchers: Brian Amsden, Lindsay Fitzpatrick, Laura Wells, and Kim Woodhouse. More information about the program can be found at: https://engineering.queensu.ca/programs/graduate-professional/collaborative/bme/.
- **Process Systems Engineering:** Process control, optimization and applied statistics, including extremum-seeking control, parameter estimation in nonlinear dynamic models, diagnostics for statistical model building and parameter estimation, and systems biology. Researchers: Martin Guay, Tom Harris, Xiang Li, Kim McAuley, Jim McLellan and Nicolas Hudon.
- **Fuel Cells:** PEM and solid oxide fuel cells, alternative feeds to fuel cells including conversion of agricultural or municipal waste, low platinum electrodes, electrokinetics, control of fuel cell systems and parameter estimation for fuel cell models. Researchers: Dominik Barz, Kunal Karan and Brant Peppley.
- **Microfluidics and Biosensors:** Microfluidics and Biosensors, electrokinetics, pathogen and biomarker detection methods,Raman spectroscopy, surface plasmon resonance, on-chip cell manipulation and analysis. Researchers: Dominik Barz, Aris Docoslis and Carlos Escobedo.

Collaborative Biomedical Engineering Program

This collaborative program links the graduate programs in Chemical, Electrical and Mechanical Engineering and provides shared learning experiences with interdisciplinary content, bringing students from a variety of backgrounds together to learn about research methodology and professional practice in the field of Biomedical Engineering. Students are registered in one of the three home departments in a Master's or Doctoral program and will receive the designation of "specialization in Biomedical Engineering" upon graduation. More information about the program can be found at https://engineering.queensu.ca/programs/graduate-professional/collaborative/bme/ and in this calendar at Biomedical Engineering (https://queensu-ca-public.courseleaf.com/graduate-studies/programs-study/biomedical-engineering/).

Collaborative Graduate Specialization in Computational Science and Engineering

A three-course specialization that teaches you the latest methods for applying the power of high-performance computing to scientific problems in your area of study. From advanced numerical analysis, mathematical modelling and simulation, and parallel programming, these methods support and enhance more traditional approaches based on theory and experimentation. Completion of requirements entitles you to a special degree notation on your transcripts.

Degree Programs

Applicants for the following programs are accepted under the general regulations of the School of Graduate Studies.

Note that courses of instruction are provided in term length (3.0 credit units) weight or modular six-week (1.5 credit units) types. Click on Chemical Engineering's Courses of Instruction (https://www.queensu.ca/sgs/graduate-calendar/courses-instruction/chemical-engineering-courses/) for details.