DOCTORATE IN PHILOSOPHY CHEMICAL ENGINEERING

Summary

- Degree offered: Doctorate in Philosophy (PhD)
- Registration status option: Full-time
- Language of instruction: English
- Program option (expected duration of the program):
  - within four years
- Academic units: Faculty of Engineering (https://engineering.uottawa.ca/), Department of Chemical and Biological Engineering (https://engineering.uottawa.ca/chemical/)

Program Description

The Department of Chemical and Biological Engineering located in the Faculty of Engineering offers graduate programs leading to the degrees of Master of Applied Science (MASc), Master of Engineering (MEng) and Doctor of Philosophy (PhD) in Chemical Engineering.

The PhD program prepares candidates for a career in teaching, research and/or development. Graduates are expected to have acquired autonomy in conducting research, preparing scholarly publications, and promoting chemical engineering.

Main Areas of Research

- Materials development
- Process engineering
- Clean technologies and renewable energy
- Biomedical engineering

Other Programs Offered Within the Same Discipline or in a Related Area

- Master of Applied Science Chemical Engineering (MASc)
- Master of Engineering Chemical Engineering (MEng)
- Master of Applied Science Chemical Engineering Specialization in Science, Society and Policy (MASc)

Fees and Funding

- Program fees

  The estimated amount for university fees (https://www.uottawa.ca/university-fees/) associated with this program are available under the section Finance your studies (http://www.uottawa.ca/graduate-studies/programs-admission/finance-studies/).

  International students enrolled in a French-language program of study may be eligible for a differential tuition fee exemption (https://www.uottawa.ca/university-fees/differential-tuition-fee-exemption/).

- To learn about possibilities for financing your graduate studies, consult the Awards and financial support (https://www.uottawa.ca/graduate-studies/students/awards/) section.

Notes

- Research activities can be conducted either in English, French or both, depending on the language used by the professor and the members of his or her research group.
- Programs are governed by the academic regulations (https://www.uottawa.ca/about-us/leadership-governance/policies-regulations/) in effect for graduate studies.
- In accordance with the University of Ottawa regulation, students have the right to complete their assignments, examinations, research papers, and theses in French or in English.

Program Contact Information

Graduate Studies Office, Faculty of Engineering (https://engineering.uottawa.ca/graduate-studies-office/)
STE 1024
800 King Edward Ave.
Ottawa ON Canada
K1N 6N5

Tel.: 613-562-5347
Fax.: 613-562-5129
Email: engineering.grad@uottawa.ca

Twitter | Faculty of Engineering (https://twitter.com/uOttawaGenie/?lang=en)
Facebook | Faculty of Engineer (https://www.facebook.com/uottawa.engineering/)

Admission Requirements

For the most accurate and up to date information on application deadlines, language tests and other admission requirements, please visit the specific requirements (https://www.uottawa.ca/graduate-studies/programs-admission/apply/specific-requirements/) webpage.

To be eligible, candidates must:

- Hold a master's degree in chemical engineering (with thesis or equivalent in terms of scholarly publications) with a minimum average of 75% (B+).

  Note: International candidates must check the admission equivalencies (https://www.uottawa.ca/graduate-studies/international/study-uottawa/admission-equivalencies/) for the diploma they received in their country of origin.

- Demonstrate a good academic performance in previous studies as shown by official transcripts, research reports, abstracts or any other documents demonstrating research skills.
- Identify at least one professor who is willing to supervise your research and thesis.
  - We recommend that you contact potential thesis supervisors as soon as possible.
  - To enroll, you need to have been accepted by a thesis supervisor.
  - The supervisor's name is required at the time of application.

Language Requirements

Applicants must be able to understand and fluently speak the language of instruction (English) in the program to which they are applying. Proof of linguistic proficiency may be required.

Applicants whose first language is neither French nor English must provide proof of proficiency in the language of instruction.

Note: Candidates are responsible for any fees associated with the language tests.

Notes

- The Department may require students to take additional courses depending on their backgrounds preparation.
- The admission requirements listed above are minimum requirements and do not guarantee admission to the program.
- Admissions are governed by the academic regulations (https://www.uottawa.ca/about-us/leadership-governance/policies-regulations/) in effect for graduate studies.

Fast-Track from Master's to PhD

Students enrolled in the master's program in Chemical Engineering at the University of Ottawa may be eligible to fast-track directly into the doctoral program without writing a master's thesis, provided the following conditions are met:

- Have been enrolled full-time in the MASc program for at least one year.
- Completed four graduate courses (12 units) with an average of at least 80% (A-).
- Written recommendation by the supervisor and by the graduate studies committee.
- Successfully completed of a minimum of 9 units in chemical engineering.

Note: The transfer must take place within sixteen months of initial enrollment in the master's. The minimal admission average requirements for the doctoral program must also be met. Following the transfer, all of the requirements of the doctoral program must be met.

Program Requirements

Requirements for this program have been modified. Please consult the 2023-2024 calendars (http://catalogue.uottawa.ca/en/archives/) for the previous requirements.

Doctorate

Students are required to conduct a minimum of nine terms of full-time research from the bachelor of applied science and six terms of full-time research from the master of applied science. Students must also meet the following requirements:

Compulsory Courses: [1]		
CHG 8333	Research Methodology and Communication	3 Units
6 optional course units above the level of the master of applied science [2, 3]		6 Units
Seminar:		
CHG 8102S	Seminar II	1 Unit
Comprehensive Examination:		
CHG 9998	Comprehensive Examination (Ph.D.) [4]	
Thesis:		
THD 9999	Doctoral Thesis [5, 6]	

Note(s)

1

The Department may require students to take additional courses, depending on their backgrounds.

2

All courses, except with permission of the Department, must be in chemical engineering.

3

Graduate Students in Chemical Engineering who have either completed their MASc at the University of Ottawa or are Fast-track eligible will be exempted up to 9 optional course units required for this Program at the Department's discretion and determined upon Admission.

4

The oral or written comprehensive examination must be done within 16 months of enrollment to be allowed to proceed further with research.

5

Students are responsible for ensuring they have met all of the thesis requirements (http://www.uottawa.ca/graduate-studies/students/theses/).

6

Students must present their thesis as a final oral examination. Students may submit their thesis in traditional monograph format or as a series of articles prepared for publication in scholarly journals.

Minimum Requirements

The passing grade in all courses is B.

Students who fail 6 units, the thesis proposal, the comprehensive exam, the thesis, or whose progress is deemed unsatisfactory must withdraw from the program.

Fast-Track from Master's to PhD

The transfer must take place within sixteen months of initial enrollment in the master's. Following the transfer, all of the normal requirements of the doctoral program must be met: a minimum number of 21 units of graduate coursework (master's 12 units and PhD 9 units); the seminar CHG 8102S; a comprehensive exam successfully completed within twelve months of transfer; and a thesis.

Research

Research at the University of Ottawa

Located in the heart of Canada's capital, a few steps away from Parliament Hill, the University of Ottawa ranks among Canada's top 10 research universities. Our research is founded on excellence, relevance and impact and is conducted in a spirit of equity, diversity and inclusion.

Our research community thrives in four strategic areas:

- Creating a sustainable environment
- Advancing just societies
- Shaping the digital world
- Enabling lifelong health and wellness

From advancing healthcare solutions to tackling global challenges like climate change, the University of Ottawa's researchers are at the forefront of innovation, making significant contributions to society and beyond.

Research at the Faculty of Engineering

Areas of research:

- Chemical and Biological Engineering
- Civil Engineering
- Electrical Engineering and Computer Science
- Mechanical Engineering

For more information, refer to the list of faculty members and their research fields on **Uniweb**.

IMPORTANT: Candidates and students looking for professors to supervise their thesis or research project can also consult the website of the faculty or department (https://www.uottawa.ca/study/graduate-studies/academic-unit-contact-information/) **of their program of choice. Uniweb does not list all professors authorized to supervise research projects at the University of Ottawa.**

Courses

Not all of the following courses are necessarily given each year. Attendance at courses is compulsory.

CHG 6000 Rapport en génie chimique / Chemical Engineering Report (6 crédits / 6 units)
Volet / Course Component: Recherche / Research

CHG 8101S Seminar I (1 crédit / 1 unit)
Oral presentation of selected topics and research papers. Attendance at all seminars is compulsory for MASc students.
Volet / Course Component: Séminaire / Seminar

CHG 8102S Seminar II (1 crédit / 1 unit)
Oral presentation of selected topics and research papers. Attendance at all seminars is compulsory for PhD students.
Volet / Course Component: Séminaire / Seminar

CHG 8113 Organic Electronics (3 units)
Ever wondered how cellphone displays work? Does the thought of tattoos that detect your sugar levels or roll-up solar panels interest you? Then you might want to learn about organic electronics. In this course students will learn the design, the fabrication and the operation of emerging printed electronics, flexible electronics and organic electronic technologies such as organic photovoltaic (OPV) devices, organic light emitting diodes (OLEDs), organic thin film transistors (OTFTs) and printed sensors. The course will cover elements of applied organic/polymer chemistry, materials engineering, physical chemistry and applied electronics. Students will touch on topics including molecular-property relationships, thin film processing, charge transport through carbon-based materials, photoexcitation of organic molecules, polymer processing, and how it all applies to emerging thin film technologies.
Course Component: Lecture

CHG 8115 Heat Transfer I (3 units)
The general law of heat conduction. Steady and unsteady heat conduction in solids with or without internal heat sources. Radiant heat transmission.
Course Component: Lecture

CHG 8116 Advanced Transport Phenomena (3 units)
Advanced study of momentum, heat and mass transfer relevant to chemical engineering and also to areas such as environmental engineering, medicine and other scientific disciplines. Review of the analogy between mass, momentum and thermal transport and, in particular, of the physical principles and mathematical foundations required for the analysis of fluid flow, heat transfer and mass transfer, and of the advanced methods for the analysis of transport problems. Main emphasis on formulation of a given physical problem in terms of appropriate conservation equations, and obtaining an understanding of the associated physical phenomena. Use of many chemical engineering applications to illustrate the various principles.
Course Component: Lecture

CHG 8121 Synthetic Membranes in Biomedical Engineering (3 units)
Medical applications of synthetic membranes hemodialysis, oxygenation, hemofiltration, apheresis and plasma exchange, biofunctional membranes, biosensors, drug delivery systems and microencapsulation. Emphasis on the types and classes of membranes available, relationship between structure and properties of membranes, and other variables, techniques for fabricating membranes, and special issues involved in the design and manufacture of synthetic membranes for medical use.
Course Component: Lecture

CHG 8123 Advanced Chemical Engineering Thermodynamics (3 units)
Presentation of the fundamentals and the contemporary research developments in chemical engineering thermodynamics. Thermodynamic properties and formulations. Properties of fluids. Stability of thermodynamic systems. Criteria of equilibrium. Evaluation of thermodynamic properties. Mathematical methods and data handling.
Course Component: Lecture

CHG 8132 Adsorption Separation Processes (3 units)
Discussion of different microporous materials and molecular sieves as adsorbents. Adsorption equilibrium and adsorption kinetics. Equilibrium adsorption of single fluids and mixtures. Diffusion in porous media and rate processes in adsorbers. Adsorber dynamics: bed profiles and breakthrough curves. Cyclic fluid separation processes. Pressure swing adsorption. Examples of commercial separation applications. This course is equivalent to ENVJ 5105 at Carleton University.
Course Component: Lecture

CHG 8157 Strategies for Engineering Process Analysis (3 units)
Statistical experimental design and analysis techniques for industrial and laboratory investigations are presented. Topics include: the nature and analysis of process variation, comparisons of two or more processes, empirical modelling of processes, applications of factorial and fractional factorial designs, mixture designs, response surface methodologies and empirical optimization techniques.
Course Component: Lecture

CHG 8161 Advanced Chemical Reaction Engineering (3 units)
Kinetics of chemical reactions and its application to chemical engineering problems. Rate expressions and heterogeneous kinetics. Preparation and evaluation of catalyst activity. Promoters and poisons. Physical properties and transfer of mass and energy in porous catalysts. Interpretation of kinetic data and determination of mechanisms of catalyzed reactions.
Course Component: Lecture

CHG 8181 Advanced Biochemical Engineering (3 units)
Kinetics of bioreactions, growth and product formation. Batch and continuous bioprocesses. Mass and heat transfer in bioreactors. Novel bioreactor design. Industrial microbiology. Animal and plant cell culture. Downstream processing. Biosensors, biological waste-water treatment, biocorrosion, bioleaching. Nitrogen fixation. Genetic engineering. This course is equivalent to ENVJ 5501 at Carleton University.
Course Component: Lecture

CHG 8187 Introduction to Polymer Reaction Engineering (3 units)
Introduction to principles governing polymerization reactions and the resultant physical properties of polymers. Theory and experimental methods for the characterization of polymers. Mechanism and kinetics of polymerization reactions with emphasis on chain-growth polymerizations. Mathematical modelling and polymer reactor design.
Course Component: Lecture

CHG 8188 Polymer Properties and Characterization (3 units)
Polymer properties are described and discussed in the context of their nature, source and means of measurement. Chemical and microstructural properties; physical states and transitions; thermal properties; mechanical properties and viscoelasticity models; degradation and stability; surface, electrical and optical properties, polymer additives; structure-property relationships.
Course Component: Lecture

CHG 8191 Selected Topics Chemical Engineering (3 units)
Selected Topics in Chemical Engineering
Course Component: Lecture

CHG 8192 Membranes in Clean Processes (3 units)
Course emphasizing the use and development of membrane separations as clean and cleaning technologies. Applications of reverse osmosis, ultrafiltration, vapour permeation and pervaporation to the treatment of industrial process and waste streams. Discussion of the fundamentals underlying each separation process. Nanostructured membrane materials. Membrane fouling models, foulant-membrane material interactions, solvent resistant membranes, aqueous and non-aqueous separations.
Course Component: Lecture

CHG 8194 Membrane Liquid Separation Processes and Materials (3 units)
Advanced topics of membrane separations including reverse osmosis, ultrafiltration, non-aqueous liquid separation, and membrane applications in biotechnology. Physical chemical criteria for separations, membrane materials, and membrane casting techniques. Basic transport equations for single and mixed solute systems. Prediction of membrane performance. Process design, specification, and analysis applications. Problem solving in membrane transport, membrane design, and membrane process design.
Course Component: Lecture

CHG 8195 Advanced Numerical Methods in Chemical and Biological Engineering (3 units)
Survey course of numerical methods for solving linear and non-linear ordinary and partial differential equations. Techniques reviewed include Runge-Kutta and predictor-corrector methods, shooting techniques, control volume discretization methods and finite elements. Example problems from the field of transport phenomena. This course is equivalent to ENVJ 5505 at Carleton University.
Course Component: Lecture

CHG 8196 Interfacial Phenomena in Engineering (3 units)
Interfacial tension and interfacial free energy; contact angles; spreading of liquids; wetting of surfaces; experimental techniques. Interfacial tension of mixtures; Gibbs equation; absorbed and insoluble monolayers; properties of monolayers and films. Electrical phenomena at interfaces; the electrical double layer; zeta-potential; electrokinetic phenomena (electrophoresis, electro-osmosis, streaming potential); surface conductance. Dispersed systems; formation and practical uses of emulsions; spontaneous emulsification; flocculation. This course is equivalent to ENVJ 5507 at Carleton University.
Course Component: Lecture

CHG 8198 Membrane Gas Separation Processes (3 units)
Familiarization with principles of membrane technology and engineering aspects of membrane separation processes, with emphasis on gas separation. Overview of membrane types and materials, mechanisms of gas transport in membranes, and applications. Zero stage-cut analysis and membrane characterization methods and multistage membrane module design.
Course Component: Lecture

CHG 8300 Electrochemical Engineering (3 units)
Basic principles and laws of applied electrochemistry. Electrochemical thermodynamics. Electrode kinetics and electrochemical double layer. Electrocatalysis for fuel cells and water electrolysis. Transport phenomena in electrochemical engineering. Electrochemical reaction engineering. Examples of industrial processes: Chloralkali-electrolysis, water electrolysis, electrowinning of Nickel, Zinc, Aluminum, organic electro-synthesis. Energy conversion and storage technology: fuel cells, electrochemical capacitors and batteries.
Course Component: Lecture

CHG 8301 Renewable Fuels (3 units)
The production and sustainability of renewable fuels: Study the various generations and types of renewable fuels. Detailed look at the processes involved in transforming renewable feedstocks into useful fuels. Evaluation of the chemical and physical exergy of substances and process streams. Exergetic efficiency of process flowsheets. Perform well to wheel energetic and exergetic life cycle analyses of fossil and biofuels. Evaluate the environmental performance of renewable fuels.
Course Component: Lecture

CHG 8302 Oil and Gas Processing (3 units)
Physical and chemical properties of hydrocarbons and their estimation methods. Typical technologies, processes, and unit operations used in the characterization and processing of natural gas, crude oils, and Canadian bitumen.
Course Component: Lecture

CHG 8303 Tissue Engineering and Regenerative Medicine Principles (3 units)
The principles applied in the fields of tissue engineering and regenerative medicine to develop prospective therapeutic solution for a range of injuries and pathologies. A general discussion on the tissue engineering paradigm and building blocks (cells, biomaterials and bioactive cues) employed to engineer tissues. A range of tissue fabrication strategies using specific tissue/organ systems as examples. How engineering concepts, including bioreactor design, are exploited to drive innovation in the field. Additional aspects of regenerative medicine.
Course Component: Lecture

CHG 8304 Biomaterials: Principles and Applications (3 units)
Classes of biomaterials, including metals, ceramics, polymers and composite materials; properties of biomaterials, characterizations of biomaterials, degradable biomaterials, modifications of biomaterials, and host responses to biomaterials. Applications of biomaterials, particularly drug delivery systems, and other applications of biomaterials in tissue engineering. Regulations on the use of biomaterials and special considerations on the use of biomaterial based implantable devices.
Course Component: Lecture

CHG 8305 Particulate and Multiphase Flow (3 units)
The principal elements in the design and scale-up of various commercially important particulates and multiphase systems such as fixed beds, spouted beds, bubble columns and fluidized beds. Topics include flow regimes, hydrodynamics, heat and mass transfer, mixing, interfacial phenomena, chemical reaction and instrumentation.
Course Component: Lecture

CHG 8306 Biopharmaceutics and Fermentation (3 units)
Biopharmaceutics: General concepts and new developments in biopharmaceutics. Antibiotics and alternatives to antibiotics, antibodies, vaccines, microRNA, gene therapeutics and viral therapeutics. Fermentation and cell culture: cell growth kinetics; operation modes; expression of recombinant protein in bacteria, yeast, plant cells, insect cells, and mammalian cells. Bioseparation: solids/liquid separation (e.g., filtration, centrifugation, precipitation). Cell disruption; product recovery (distillation, membrane separation, ion exchange, affinity adsorption, solvent extraction, aqueous extraction, crystallization); concentration and drying (thin film evaporator, spray drying, frozen drying).
Course Component: Lecture

CHG 8333 Research Methodology and Communication (3 units)
Tools and principles for efficient and proficient scientific communication and research project management. Best practices for preparing and delivering oral presentations to various audiences, and writing scientific papers, thesis and reports. Research methodology. Research project planning. Design of experiments with long-term and short-term objectives.
Course Component: Lecture

CHG 9998 Examen de synthèse (doctorat) / Comprehensive Examination (Ph.D.)
Volet / Course Component: Recherche / Research