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):
  - with thesis (16 full-time terms; 64 consecutive months)
- Academic units: Faculty of Engineering, Department of Chemical and Biological Engineering

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 general regulations (http://www.uottawa.ca/graduate-studies/students/general-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 (http://engineering.uottawa.ca/about/programs/graduate)

161 Louis-Pasteur, Colonel By Hall, room B111
Ottawa, Ontario, Canada
K1N 6N5

Tel.: 613-562-5800 x6189
Email: engineering.grad@uottawa.ca

Twitter | Faculty of Engineering (https://twitter.com/uOttawaGenie?lang=en)

Facebook | Faculty of Engineering (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 (http://www.uottawa.ca/graduate-studies/programs-admission/apply/specfic-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 (http://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.
- Pay the $100 (SCDN non-refundable) application fee.
- 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.

Language tests recognized by the University of Ottawa:

- TOEFL: 550 (paper-based) or 79-80 (internet-based); or
- IELTS: Overall 6.5 – Individual 5.0 (paper-based or internet-based); or
- An equivalent language test (http://www.uottawa.ca/graduate-
  studies/programs-admission/apply/required-documents).

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 general regulations (http://
  www.uottawa.ca/graduate-studies/students/general-regulations) in
  effect for graduate studies.

Documents Required for Admission

In addition to the documents required (http://www.uottawa.ca/graduate-
studies/programs-admission/apply/required-documents) for graduate
and postdoctoral studies, candidates must submit the following
documents:

- A resume
- A letter of intent
  Letter outlining your professional goals and proposed research
  area.
- Two confidential letters of recommendation from professors who
  have known the applicant and are familiar with their work.
  It is highly recommended that you contact your referee prior to
  submitting your application to confirm their email address and their
  availability to complete your letter of recommendation.
- Transcripts from all universities attended.
  - Official transcripts from all universities attended must be
    submitted (mandatory).
    This applies to all courses and programs at any university
    you attended, including regular programs (completed or not),
    exchanges, letters of permission, online or correspondence
    courses, courses taken as a special student or visiting student,
    etc.
  - If the transcript and degree certificate are not in English or
    French, a certified translation (signed and stamped/sealed) must
    be submitted.

Note: Documents that are not required for admission will not be
consulted, conserved or returned to the student. These documents will be
destroyed according to our administrative procedures.

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.

Information about how to apply to this program is
available under the Apply Now (http://www.uottawa.ca/
graduate-studies/programs-admission/apply/#apply-
now) section.

Students should complete and submit their online application with
supporting documentation (if applicable) by the deadline indicated above.

Program 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

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<tr>
<td>CHG 8102S</td>
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Seminar:

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Comprehensive Examination:

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Thesis:
Areas of research:

Research at the Faculty of Engineering educators strongly influence national and international priorities. uOttawa focuses research strengths and efforts in four Strategic Areas of Development (SADRs):

1. Canada and the World
2. Health
3. e-Society
4. Molecular and Environmental Sciences

With cutting-edge research, our graduate students, researchers and educators strongly influence national and international priorities.

**Research**

**Research Fields & Facilities**

Located in the heart of Canada’s capital, a few steps away from Parliament Hill, the University of Ottawa is among Canada’s top 10 research universities.

uOttawa focuses research strengths and efforts in four Strategic Areas of Development in Research (SADRs):

- 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/graduate-studies/students/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 7999 Thèse de M.Sc.A. / M.A.Sc. Thesis**

**Volet / Course Component:** Recherche / Research

**CHG 8101S Séminaire I (1 crédits / 1 units)**

Oral presentation of selected topics and research papers. Attendance at all seminars is compulsory for MAsc students.

**Volet / Course Component:** Séminaire / Seminar

**CHG 8102S Séminaire II (1 crédits / 1 units)**

Oral presentation of selected topics and research papers. Attendance at all seminars is compulsory for PhD students.

**Volet / Course Component:** Séminaire / Seminar

**CHG 8110 Fluid Mechanics (3 units)**

Stream function, circulation and vorticity, form drag and drag coefficients, equations of motion, boundary layer theory, modern theory of turbulent motion, flow in porous media, non-Newtonian flow.

**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 8120 Rheology and Polymer Processing (3 units)**


**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 Chemical Engineering Thermodynamics (3 units)
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 8141 Special Directed Studies I (3 units)
Course Component: Lecture

CHG 8143 Special Directed Studies II (3 units)
Course Component: Lecture

CHG 8145 Special Directed Studies III (3 units)
Course Component: Research

Discrete, linear, stochastic models for dynamic processes. Univariate Time Series. Identification of transfer function models. Fitting and checking transfer function models. Design of feedback and feedback control schemes. Applications to chemical processes. This course is equivalent to ENVJ 5500 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 8158 Porous Media (3 units)
Course Component: Lecture

CHG 8161 Chemical Reaction Engineering I (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 8175 Material Transport (3 units)
Course Component: Lecture

CHG 8181 Biochemical Engineering (3 units)
Course Component: Lecture

CHG 8186 Modelling of Steady-State Processes (3 units)
A comprehensive examination of techniques for building and analyzing process models is made. Topics include: linear least squares estimation, non-linear least squares estimation, multiresponse parameter estimation, error in variables estimation, heteroscedasticity, design of experiments for precise parameter estimation and model discrimination. This course is equivalent to ENVJ 5506 at Carleton University.
Course Component: Lecture

CHG 8187 Introduction to Polymer Reaction Engineering (3 units)
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 8189 Chemical Engineering Analysis (3 units)
Treatment and interpretation of experimental data. Formulation of ordinary and partial differential equations for the solution of problems arising in chemical engineering. Emphasis will be on problems requiring numerical techniques with examples taken from fluid flow, heat transfer and mass transfer. Selection of boundary conditions.
Course Component: Lecture

CHG 8191 Selected Topics Chemical Engineering (3 units)
Discussion of recent progress in chemical engineering. This course is equivalent to ENVJ 8191 at Carleton University.
Course Component: Lecture
CHG 8192 Membrane Application in Environmental Engineering (3 units)
Course emphasizing the applications of membrane separation processes in the resolution of various environmental problems. Applications of reverse osmosis, ultrafiltration and pervaporation to the treatment of industrial waste waters. Applications of membrane gas and vapor permeation to the removal of pollutants from air. Discussion of fundamentals underlying each separation process. This course is equivalent to ENVJ 5502 at Carleton University.

Course Component: Lecture

CHG 8194 Membrane Separation Processes (3 units)
Advanced topics of membrane separations including reverse osmosis, ultrafiltration, gas separation, non-aqueous liquid separation, and membrane applications in biotechnology. The course involves problem solving in membrane transport, membrane design, and membrane process design. This course is equivalent to ENVJ 5504 at Carleton University.

Course Component: Lecture

CHG 8195 Advanced Numerical Methods in Transport Phenomena (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 Reverse Osmosis (3 units)
Physical chemical criteria for reverse osmosis 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. This course is equivalent to ENVJ 5503 at Carleton University.

Course Component: Lecture

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

CHG 9999 Thèse de doctorat / Ph.D. Thesis
Volet / Course Component: Recherche / Research