MASTER OF APPLIED SCIENCE CHEMICAL ENGINEERING SPECIALIZATION IN SCIENCE, SOCIETY AND POLICY

Summary
• Degree offered: Master of Applied Science (MASc)
• Registration status options: Full-time; Part-time
• Language of instruction: English
• Primary program: MASc in Chemical Engineering
• Collaborative specialization: Science, Society and Policy
• Program option (expected duration of the program):
  • with thesis (6 full-time terms; 24 consecutive months)
• Academic units: Faculty of Engineering (http://engineering.uottawa.ca), Department of Chemical and Biological Engineering (https://engineering.uottawa.ca/chemical), Institute for Science, Society and Policy (http://issp.uottawa.ca/en)

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 main objective of the master’s programs is to refine the skills and research expertise of the students by expanding their specialized knowledge of chemical engineering primarily achieved through course work, research seminars, and technical training.

The Department is one of the participating units in the collaborative program in Science, Society and Policy.

Collaborative Program Description
The collaborative program in Science, Society and Policy allows students enrolled in one of the participating master’s programs to specialize in science and innovation policy.

The objective of the collaborative program is to provide students with the knowledge and skills needed to evaluate the challenges confronting decision-making at the interface of science and policy. Students will have an opportunity to explore how evidence is used in decision-making, how current policies shape the scientific enterprise, and how emerging technologies interact with society.

The degree awarded specifies the primary program and indicates "Specialization in Science, Society and Policy."

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 Science Biology Specialization in Science, Society and Policy (Msc)
• Master of Science Chemistry Specialization in Science, Society and Policy (Msc)
• Doctorate in Philosophy Chemical Engineering (PhD)

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

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.

Notes
• To be accepted into the collaborative program candidates must be admitted to one of the programs participating in the collaborative program.
• Students must indicate in their initial application for admission to the master’s program in chemical engineering that they wish to be accepted into a collaborative specialization in Science, Society and Policy.
• The Department may require students to take additional courses, depending on their backgrounds.
• 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:
Program Requirements

Master’s with Collaborative Specialization

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

Students must meet the following requirements for the master’s with collaborative specialization:

**Compulsory Courses (CHG):**

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<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
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<tbody>
<tr>
<td>CHG 6000</td>
<td>Chemical Engineering Report</td>
<td>6 units</td>
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**Seminar:**

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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
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<tbody>
<tr>
<td>CHG 8101S</td>
<td>Seminar I</td>
<td>1 unit</td>
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**Compulsory Courses (ISP):**

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<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
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<tbody>
<tr>
<td>ISP 5101</td>
<td>Decision at the Interface of Science and Policy</td>
<td>3 units</td>
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**Thesis:**

<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>THM 7999</td>
<td>Master’s Thesis</td>
<td>0 unit</td>
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Note(s)

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

**Minimum Requirements**

The passing grade in chemical engineering courses is C+.

The passing grade in ISP courses is B.

A student who has incurred two failures is withdrawn from the program.

**Fast-Track from Master’s to PhD**

Students enrolled in the MASc program at the University of Ottawa may be eligible to fast-track directly into the doctoral program without writing a master’s thesis. For additional information, please consult the “Admission Requirements” section of the PhD program.

**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):

- Canada and the World
- Health
- e-Society
- Molecular and Environmental Sciences

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

**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/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 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 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)
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)
Course Component: Lecture

CHG 8182 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 8183 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 8184 Membrane Liquid Separation Processes and Materials (3 units)
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)

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

ISP 5101 Decision at the Interface of Science and Policy (3 units)
This course explores a number of critical issues in the design and implementation of science (or, more generally, evidence)-based policy. Topics will include: the nature of scientific evidence; who has standing in the provisioning of scientific evidence; the science and non-science of risk assessment; ethical dimensions of policy design and implementation; the role of science in policy design and implementation; the policy making process; and science policy performance evaluation.

Course Component: Lecture
ISP 5102 Science and Technology Governance and Communication (3 units)
This course explores a number of critical issues in the governance of science and technology (S&T) in democratic societies, with particular emphasis on the Canadian context. Topics will include the following: the history of S&T governance and communication in both Canada and abroad; an overview of the Canadian S&T policy and regulatory landscape; the role of government, the private sector and civil society in S&T governance; policy and regulatory experiments in fostering innovation (and the success thereof); the evolution of public S&T communication strategies and governance of emerging technologies.
**Course Component:** Lecture

ISP 5103 Capstone Seminar in Science, Society and Policy (3 units)
Involves partnering with organization(s) working on an issue relating to science, society and policy. In consultation with a member of the organization, students analyze the issue and complete a written report, either singly or in interdisciplinary teams, under the direction of the seminar professor who is responsible for evaluating the report.
**Course Component:** Lecture

ISP 5501 Prise de décision à l'interface de la science et des politiques (3 crédits)
Ce cours approfondit un certain nombre d'enjeux critiques liés à la conception et à la mise en oeuvre de politiques scientifiques (ou, de façon plus générale, fondées sur des preuves). Les sujets abordés incluent les suivants : la nature de la preuve scientifique; qui a qualité pour fournir des preuves scientifiques; le côté scientifique et le côté non scientifique de l'évaluation des risques; les dimensions éthiques de la conception et de la mise en oeuvre des politiques publiques; le rôle de la science dans la conception et la mise en oeuvre des politiques publiques; le processus d'élaboration des politiques publiques; et l'évaluation du rendement des politiques publiques en matière de sciences.
**Volet:** Cours magistral

ISP 5502 Gouvernance et communication en science et technologie (3 crédits)
Ce cours approfondit un certain nombre d'enjeux critiques liés à la gouvernance des sciences et de la technologie (S et T) dans les sociétés démocratiques et, en particulier, dans le contexte canadien. Les sujets abordés incluent les suivants : l'histoire de la gouvernance et de la communication en sciences et technologie au Canada et à l'étranger; un aperçu du paysage réglementaire et politique canadien ayant trait aux sciences et à la technologie; le rôle du gouvernement, du secteur privé et de la société civile dans la gouvernance des sciences et de la technologie; les expériences relatives aux politiques et à la réglementation menées en vue de favoriser l'innovation (et leur réussite); l'évolution des stratégies de communication publique concernant les sciences et la technologie et la gouvernance des nouvelles technologies.
**Volet:** Cours magistral

ISP 5503 Séminaire d'intégration en science, société et politique publique (3 crédits)
Involves partnering with organization(s) working on an issue relating to science, society and policy. In consultation with a member of the organization, students analyze the issue and complete a written report, either singly or in interdisciplinary teams, under the direction of the seminar professor who is responsible for evaluating the report.
**Volet:** Cours magistral