

CHEMICAL ENGINEERING

CURRICULUM

Master of Applied Science

DEGREE REQUIREMENTS

	Credits
Master's Thesis	(Milestone)
Master's Seminar	(Milestone)
Four electives (maximum of one from Group II)	4

Master of Engineering

DEGREE REQUIREMENTS

	Credits
Master's Project*	(Milestone)
Eight Electives (max. of two from Group II)	8

* Students may apply to substitute two courses for the Project

Doctor of Philosophy

DEGREE REQUIREMENTS

	Credits
Dissertation	(Milestone)
Doctoral Seminar	(Milestone)
Four Elective credits from Group I	4

ELECTIVES

	Credits
Group I	
CE8139 Prob, Stat and Stochastic Proc	1
CE8201 Model and Simulation- Chem Eng	1
CE8202 Advanced Process Control	1
CE8203 Applied Optimal Control	1
CE8213 Advanced Numerical Methods	1
CE8301 Advanced Transport Phenomena	1
CE8303 Advanced Fluid Dynamics	1
CE8304 Rheology	1
CE8401 Ind Catalysis and Biocatalysis	1
CE8402 Applied Thermodynamics	1
CE8501 Polymer Science	1
CE8502 Polymerization Reaction Engr	1
CE8602 Industrial Biotechnology	1
CE8603 Advances in Biomaterials	1
CE8604 Advances in Porous Materials	1
CE8605 Nanobiotechnology	1
CE8702 Dsgn/Oper Sm Wtr Treat Plants	1
CE8703 Adv Water Treatment Tech	1
CE8803 Advanced Food Process Engineering	1
CE8100 Directed St: Chem Eng (MAsc)	1
CE9100 Directed St: Chem Eng (PhD)	1
Group II	
CE8210 Process and Engr Optimization	1
CE8310 Fluidization Engineering	1
CE8331 Membrane Technology	1
CE8510 Plastic Technology	1

COURSE LISTING

Master's Thesis

The student is required to conduct advanced research on a topic related to chemical engineering mainly in the water-wastewater/food treatment and polymer/chemical processing areas. The research topic is selected in consultation with the student's supervisor(s), where the student presents an outline of the research plan in writing, and the research is carried out under the direction of a faculty supervisor(s) and monitored by a thesis supervisory committee. On completion, the student is required to give an oral presentation on the research results in the Graduate Research Seminar Series. The research results are then submitted in a thesis format to the supervisor(s) and to an examining committee, before which an oral presentation is made for the assessment and grading of the thesis. Through the thesis, the student is expected to provide evidence of competence in carrying out research and a sound understanding of the material associated with the research. This is a "Milestone." Pass/Fail

Master's Project

The student is required to conduct an applied advanced research project on a topic related to chemical engineering. The project topic is selected in consultation with the student's advisor, where the student presents an outline of the project plan in writing, and then is carried out under the direction of a faculty advisor and monitored by an advisory committee. On completion of the project, the results are submitted in a technical report format to the advisor and then to an examining committee, which an oral presentation is made for assessment and grading of the project and the report. The student is expected to provide evidence of competence in the carrying out of a technical project and present a sound understanding of the material associated with the research project. This is a "Milestone." Pass/Fail

Master's Seminar

This course consists of presentations by graduate students, faculty members, visiting scholars, and guest speakers. In order to pass this course, the MASc student is required to attend all seminars while in the program and give one presentation towards the end of his/her thesis. This is a "Milestone." Pass/Fail

Doctoral Dissertation

The PhD student is required to conduct advanced research on a topic related to chemical engineering, mainly in the water-wastewater/food treatment and polymer/chemical processing areas. The research topic is selected in consultation with the student's supervisor(s). The student presents a proposal of the research plan in writing to a supervisory committee, and orally in the Graduate Research Seminar Series prior to taking a candidacy exam. The research is carried out under the direction of a faculty supervisor(s) and monitored by a supervisory committee. On completion, the student is required to give an oral presentation on the research results in the Graduate Research Seminar Series. The research results are then submitted in a dissertation format to the supervisor(s) and to an examining committee, before which an oral presentation is made for the assessment and grading of the dissertation. Through the dissertation, the student is expected to provide evidence of competence in carrying out original and independent research and a sound understanding of the material associated with the research. Pass/Fail

Doctoral Seminar

This course consists of presentations by graduate students, faculty members, visiting scholars, and guest speakers. In order to pass this course, the PhD student is required to attend all seminars while in the program, and give one presentation before his/her candidacy exam and one presentation towards the end of the dissertation. This is a "Milestone." Pass/Fail

CE8100 Directed Studies in Chemical Engineering (MASc)

This course is for master's students who wish to gain knowledge in a specific area for which no graduate level classes are offered. This course would involve a directed study for which the student(s) would be given credit. Students wishing to take the class would be assigned a suitable class advisor most familiar with the specific area of interest. Students would be required to present the work of one term (not less than 90 hours in the form of directed research, tutorials and individual study), in an organized publication format. 1 Credit

CE8139 Probability, Stats. & Stochastic Processes

This course is an introduction to stochastic processes and probabilistic models. Statistical inference techniques are also discussed. Topics covered include: probability and random variables, Bernoulli, Binomial, Markov, Poisson, Wiener and Gaussian models, stationarity and cyclostationarity, spectra of various signals, linear mean-square estimation, representation of random signals and Karhunen-Loeve expansion, Markov chains and processes, parameter estimation, mean variance, confidence intervals, Bayesian models, hypothesis testing. Antirequisite EN8910, ME8139. 1 Credit

CE8201 Modelling & Simulation in Chemical Eng.

Principles of process modeling; modeling of steady state, and unsteady state processes leading to problem formulation; numerical solutions of linear and non-linear algebraic equations, ordinary differential equations, and partial differential equations; analytical solutions of ordinary and partial differential equations; advanced techniques of computer programming; introduction to object-oriented paradigm; computer simulation of chemical engineering processes; examples from thermodynamics, fluid mechanics, heat transfer, mass transfer, and chemical reaction engineering. 1 Credit

CE8202 Advanced Process Control

System identification. Review of linear control systems and state space. Design methods of multivariable control systems. Model Predictive Control: Internal Model Control (IMC) and Dynamic Matrix Control. Applications to chemical processes. 1 Credit

CE8203 Applied Optimal Control

Extreme values of functionals; theory of first variation; sufficient conditions for a strong relative extremum; Hamilton-Jacobi theory and Pontryagin's minimum principle; variational problems with constraints; Lagrange problem; Mayer problem; isoperimeter problem; fundamental theorem on undetermined systems; theory of second variation; formulation of optimal control problems; determination of optimal controls and trajectories with using numerical methods and computational techniques. 1 Credit

CE8210 Process & Engineering Optimization

The use of optimization methods is pervasive throughout the process industries. Thus, these techniques are an important part of a chemical engineer's tool set. This course will provide a blend of important theoretical concepts and practical implementation issues. The development of a student's ability to formulate optimization problems, select solution techniques and interpret results will be emphasized. Finally, through a series of industrially relevant problem sets, the students will gain exposure to popular optimization software. Extra project/assignments are required, weighing no less than 20-30% of the final grade. Antirequisite CHE425. 1 Credit

CE8213 Advanced Numerical Methods

Review of numerical analysis. Includes: solution of systems of linear and nonlinear algebraic equations, interpolation, least squares fitting, integral and derivative evaluations, and solution of ordinary and partial differential equations. Introduction to the numerical solution of systems of linear and nonlinear partial differential equations using finite difference and finite element methods. Includes: error analysis, non-uniqueness and stability in nonlinear systems, continuation, isoparametric mapping, time integration techniques, time step controller, and mesh refinement strategies. Includes practical applications to science and engineering. Programming is required throughout the course. Antirequisite EN8913. 1 Credit

CE8301 Advanced Transport Phenomena

Differential and integral balances applied to isothermal and non-isothermal systems, interphase transport in non-isothermal, single component and multi-component systems. Heat and mass transfer in packed and fluidized beds. 1 Credit

CE8303 Advanced Fluid Dynamics

Vectors and tensors; introduction to fluid dynamics; kinematics; microscopic mass and momentum balances; exact solutions of the Navier-Stokes equations; dimensional analysis and similitude; flows with negligible acceleration; high Reynolds number flows; regions far from boundaries (the Boundary Layer Theory); hydrodynamic stability; turbulence; macroscopic balances for isothermal systems; non-Newtonian fluid behaviour. 1 Credit

CE8304 Rheology

Rheology is the study of the deformation and flow of matter. This field is dominated by inquiry into the flow behavior of complex fluids such as polymers, foods, biological systems, slurries, suspensions, emulsions, pastes, and other compounds. The students will be introduced to the principles, measurements, and applications of rheology. 1 Credit

CE8310 Fluidization Engineering

Introduction to the Unit Operation. The phenomenon and its industrial relevance. Determining variables. Intervals and their effect. Two-phase and three-phase fluid beds. Entrainment, Elutriation and TDH. Introduction to pneumatic transport. Gas-solid separators. Chemical reactors. Combustion in fluid beds. Circulating and pressurized fluid beds. Transport phenomena: Heat and mass transfer. Design of fluid bed processes and their components. Current fluid bed technology. Experimental innovations. Extra project/assignments are required, weighing no less than 20-30% of the final grade. Antirequisite CHE427 1 Credit

CE8331 Membrane Technology

A study of material transport in membranes and of the modes of operation. Modeling of mass transfer in membrane processes will also be discussed. Emphasis will be on the design and applications of various membrane processes in industry, such as: membrane filtration, reverse osmosis, gas permeation and pervaporation. Extra project/assignments are required, weighing no less than 20-30% of the final grade. Antirequisite CHE715. 1 Credit

CE8401 Kinetics of Ind. Catalysis & Biocatalysis

Homogeneous catalysis reactions such as acid-base catalyses, ion catalyses, enzyme catalyses, chain reactions and polymerization will be considered. Enzymatic and microbial heterogeneous catalyses will also be described. Studies of some important industrial reactions will be made. 1 Credit

CE8402 Applied Thermodynamics.

Definitions and basic principles; conservation of mass and energy; concept of entropy; equations of change with applications; thermodynamic properties and their determination based on the change of state of system; equilibrium and stability criteria, and their applications to single and multi-component systems; Gibbs free energy and the concept of fugacity; phase equilibrium and its calculation using various thermodynamic models, and computational algorithms; chemical equilibrium in single-phase systems; chemical equilibrium of reacting mixtures; combined phase and chemical equilibrium. 1 Credit

CE8501 Polymer Science

Definitions and basic principles; polymerization mechanisms; kinetics of polymerization reactions; thermodynamics of polymer-solvent phase equilibria; diffusion and mass transfer in polymer systems; heat transfer and non-isothermal effects in polymer systems; polymer processing; mathematical modeling of mixing, extrusion, postdie processing, molding and forming. 1 Credit

CE8502 Polymerization Reaction Engineering

Introduction to polymerization. Chain growth polymerization. Kinetic model of radical polymerization, gel effect, molecular weight distribution. Stereoregulation of polymerization by Ziegler-Natta catalysis. Kinetic models. Principles of polymer reactor modeling: Batch, semi-batch and continuous reactors. Population balance equation for molecular weight. Introduction to control of polymerization reactors. 1 Credit

CE8510 Plastic Technology

Materials: classification and general properties of plastics, thermosets, thermoplastics, commodity plastics, engineering plastics, fillers and reinforcements. Polymer manufacturing processes. Converting operations: injection moulding, compression moulding, extrusion, blow moulding, wire and cable coating, thermoforming. Extra project/assignments are required, weighing no less than 20-30% of the final grade. Antirequisite CHE451. 1 Credit

CE8602 Industrial Biotechnology

A lecture and assignment course on the chemical, physical and biological aspect of industrial processes; the newly-emerging DNA-based methods for the identification and classification of bacteria of environmental, medical, food and agricultural importance. Introduction to regulatory guidelines, licensing and safety issues for the biotechnology industry. Assignments include problem-solving, proposal and report writing, and oral presentations. 1 Credit

CE8603 Advances in Biomaterials

This course introduces principles of materials engineering, important aspects of biocompatibility and response of the tissues to biomaterials, fundamentals of biomaterials engineering including design of new biomaterials for biomedical applications such as dental, orthopedics, and artificial implants. 1 Credit

CE8604 Advances in Porous Materials

Introduction and classifications of porous materials. Syntheses and characterizations of porous materials. Self-assembly and nanotechnology of porous materials. Adsorption and diffusion in porous materials. Applications of porous materials in heterogeneous catalysis, membranes for environmental remediation, and sustainable energy. 1 Credit

CE8605 Nanobiotechnology

This course introduces the fundamental concepts of nanobiotechnology and the up-to-date application of nanotechnology in life science. It has the objective of investigating emerging frontiers in achieving the goals of biotechnology through the use of nanotechnology as well. It also integrates materials science, chemical engineering, physics and life science toward the biological and biochemical applications. In this course, nanofabrication and the interaction between nanostructured materials and biological system at the nano-scale are all investigated thoroughly. Mainly, it teaches how to design and develop nano-devices that have application in the biomedical field targeting the improvement of healthcare industry. 1 Credit

CE8702 Design Operat.of Sm.Water Treat. Plants

Small water treatment plants (less than 20,000 PE) for industrial and domestic effluents play a central role in the overall water treatment policies of both developed and developing countries. The characteristics of these plants differ from those of large urban plants. Biofilm technologies like Rotating Biological Contractors, and Three-phase Fluidized Beds as well as Extended Aeration will be discussed from the point of view of design and operation. Other separation and disinfection technologies will be presented in conjunction with the treatment units. 1 Credit

CE8703 Adv. Water Treatment Technologies

Covers the sources of water and wastewater, and analytical characterization of water and wastewater. It also covers advanced oxidation technologies such as UV, UV/hydrogen peroxide, photocatalysis, and other advanced oxidation processes. Biological treatment of water and wastewater will also be discussed. 1 Credit

CE8710 Air Pollution and Control

A study of air pollution and general control methods. Air pollution measurements and emission estimates will be discussed. Fixed-box and diffusion models for air pollutant concentration will be introduced. Emphasis will be given on design of typical air pollution control equipment for volatile organic compounds (VOC), sulphur dioxide, nitrogen oxides. Introduction to control of particulate pollutants will also be included. Extra project/assignments are required, weighing no less than 20-30% of the final grade. Antirequisite CHE615. 1 Credit

CE8802 Wastes from Food Processing

Sources, composition and properties of wastes in the food processing industry. Interaction between chemical components and microorganisms present in food wastes. Biotransformations. Introduction to regulatory guidelines. Systematic procedures for the design of waste process plants, process requirements, utility needs, and associated capital and operating costs. 1 Credit

CE8803 Advanced Food Process Engineering

Modeling of food properties. Momentum, heat and mass transfer applied to the control of moisture, microbial population, and nutritive/organoleptic properties of foods during processing operations. Optimization and scale up design. Quality systems design. 1 Credit

CE9100 Directed St in Chemical Engineering (PhD)

This course is for PhD students who wish to gain knowledge in a specific area for which no graduate level class is offered. It would involve a directed study for which for which the student would be given credit. Students wishing to take the class would be assigned

an advisor most familiar with the specific area of interest. Students would be required to present the work of one term (not less than 90 hours in the form of directed research, tutorials and individual study), in an organized publication format. 1 Credit