CHEMICAL ENGINEERING (CHG)

CHG 1125 Chemical Engineering Fundamentals (3 units)
Chemical Engineering profession in relation to the chemical process industry. System of units, dimensions. Processes, process variables and flowcharts. Material balances: single and multiple units, recycle and bypass, reactive and non-reactive systems. Chemical equilibrium, single-phase and multi-phase systems, solutions, phase diagrams. Introduction to energy balances. Unit operations and instrumentation. Introduction to problem solving techniques and use of spreadsheets.
Course Component: Lecture, Tutorial
CHM 1311 or CHM 1301 is corequisite to CHG 1125.

CHG 1371 Numerical Methods and Engineering Computation in Chemical Engineering (3 units)
Study of advanced techniques in Excel and coding in Visual Basic for Applications (VBA). Numerical methods common to chemical engineering analysis and design, including linear least squares, empirical model building, methods for solving nonlinear equations and systems of equations using programming and Excel Solver, numerical integration and the solution of differential equations. Theory behind the methods and, equally important, when and how to apply them using Excel and VBA to solve engineering problems.
Course Component: Lecture, Tutorial
Prerequisite: CHG 1125.

CHG 1525 Principes de base du génie chimique (3 crédits)
Le génie chimique et son rôle dans l'industrie des procédés. Systèmes d'unités, dimensions. Procédés et variables de procédés et diagrammes de procédé. Bilans de matière: procédés à une ou plusieurs unités, recyclage, circuit alternatif, systèmes réactifs et non-réactifs. Équilibre chimique, système à une et plusieurs phases, solutions, diagrammes de phase. Introduction aux bilans d'énergie. Opérations unitaires et instrumentation. Introduction aux techniques de solutions de problèmes et l'utilisation d'un chiffrier.
Volet : Cours magistral, Tutoriel
Concomitant : CHM 1711 ou CHM 1701.

CHG 1771 Méthodes numériques et programmation en génie chimique (3 crédits)
Étude des techniques avancées du logiciel Excel et la programmation dans l'environnement Visual Basic for Applications (VBA). Méthodes numériques communes à l'analyse et aux techniques de conception en génie chimique, y compris la méthode des moindres carrés, la construction de modèles empiriques, les méthodes de résolution des équations non linéaires et des systèmes d'équations par l'emploi de la programmation et de Solver de Excel, l'intégration numérique et la solution des équations différentielles. Théorie derrière les méthodes ainsi que leurs applications aux problèmes d'ingénierie en utilisant Excel et VBA.
Volet : Cours magistral, Tutoriel
Préalable: CHG 1525.

CHG 2312 Fluid Flow (3 units)
Application of fluid flow principles to the solution of engineering problems. Macroscopic mass, momentum, and energy balances. Newtonian and non-Newtonian fluids, compressible and incompressible fluids. Friction factors and Reynolds numbers for flow in conduits, around submerged objects, in packed beds and porous media. Fluidization. Flow measurement, dimensional analysis.
Course Component: Lecture, Tutorial
Prerequisite: CHG 1125.

CHG 2314 Heat Transfer Operations (3 units)
Steady-state heat conduction in solids with and without extended surfaces. Natural and forced convective heat transfer. Transient heat conduction. Heat exchangers. Boiling heat transfer. Condensation. Evaporation. Thermal radiation.
Course Component: Lecture, Tutorial
Prerequisites: CHG 2312, MAT 2384.

CHG 2317 Introduction to Chemical Process Analysis and Design (3 units)
Process analysis and design using mass and energy balances. Thermodynamic data and relationships. Simultaneous mass and energy balances on reactive and non-reactive systems. Mixing and solutions. Balances on transient processes. Introduction to computer-aided process calculations and design.
Course Component: Lecture, Tutorial
Prerequisite: CHG 1125.

CHG 2324 Fundamentals and Applications of Chemical Engineering Thermodynamics (3 units)
First and second laws of thermodynamics. PVT behaviour of fluids. Equations of state. Thermal chemical effects. Estimation of physical-chemical properties. Applications of thermodynamics to various processes in the field of chemical engineering.
Course Component: Lecture
Prerequisite: CHG 2317.

CHG 2712 Mécanique des fluides (3 crédits)
Applications des principes d'écoulement des fluides pour la résolution des problèmes d'ingénierie. Bilans macroscopiques de conservation de la matière, de la quantité de mouvement et de l'énergie. Fluides newtoniens et non newtoniens. Fluides compressibles et incompressibles. Facteurs de friction et nombres de Reynolds pour les écoulements dans des conduites, autour des objets et dans les lits fixes. Fluidisation. Mesures des débits. Analyse adimensionnelle.
Volet : Cours magistral, Tutoriel
Préalable : CHG 1525.

CHG 2714 Transfert de chaleur (3 crédits)
Conduction de la chaleur en régime stationnaire dans les solides avec et sans ailettes. Convection naturelle et assistée. Conduction de la chaleur en régime transitoire. Échangeurs de chaleur. Transfert de chaleur par ébullition. Condensation. Évaporation. Rayonnement thermique.
Volet : Cours magistral, Tutoriel
Préalables : CHG 2712, MAT 2784.

CHG 2717 Introduction à l'analyse et la conception des procédés chimiques (3 crédits)
Analyse et conception des procédés en utilisant des bilans de matière et d'énergie. Relations et données thermodynamiques. Bilans simultanés de matière et d'énergie pour des systèmes réactifs et non-réactifs. Mélanges et solutions. Bilans sur des procédés transitoires. Introduction aux calculs et conception des procédés assistés par ordinateur.
Volet : Cours magistral, Tutoriel
Préalable : CHG 1525.

CHG 2724 Principes et applications de thermodynamique en génie chimique (3 crédits)
Première et deuxième lois de la thermodynamique. Comportement PVT des fluides. Équations d'état. Effets chimiques-thermiques. Évaluation des propriétés physico-chimiques. Application de la thermodynamique à divers procédés dans le domaine du génie chimique.
Volet : Cours magistral
Préalable: CHG 2717.

CHG 3111 Unit Operations (3 units)
Design of industrial equipment for evaporation, drying, humidification, absorption and stripping in plate and packed towers, distillation, liquid-liquid extraction and adsorption.
Course Component: Lecture, Tutorial
Prerequisite: CHG 3316.

CHG 3112 Process Synthesis, Design and Economics (3 units)
Flowsheet synthesis including process, and piping and instrumentation diagrams (PFD, P&ID). Synthesis of process design structure, separation systems, and heat-exchange networks. Process design heuristics. Plant capital and operating cost estimation. Use of commercial process simulation software.
Course Component: Laboratory, Lecture
Prerequisites: (CHG 2324 or CHG 3324), (ECO 1192 or GNG 2101).
CHG 3111 is corequisite to CHG 3112.

CHG 3122 Chemical Engineering Practice (3 units)
Laboratory course intended to demonstrate practical aspects of chemical engineering and to develop skills in written communication and engineering judgment. Students carry out experiments dealing with fluid mechanics, heat transfer and thermodynamics, with emphasis on computerized data acquisition and analysis techniques. Effective technical report writing. Principles of professional engineering practice and ethics, the societal and environmental obligations of the engineer, and workplace health and safety.
Course Component: Laboratory, Lecture
Prerequisites: CHG 2312, CHG 2314, (CHG 2324 or CHG 3324).

CHG 3127 Chemical Reaction Engineering (3 units)
The principles of reaction engineering, including a systematic approach to the design of reactors housing single and multiple reactions. Techniques for sizing and evaluating the performance of continuous flow and batch reactors under isothermal and non-isothermal conditions, as well as during significant pressure drop. Introduction to catalysis and techniques for determining rate expressions for catalytic reactions.
Course Component: Lecture, Tutorial
Prerequisites: CHG 1371 or CHG 3331.

CHG 3305 Advanced Materials in Chemical Engineering (3 units)
An introduction to the fundamentals of materials science with special emphasis on materials and applications of interest to chemical engineers. Biocompatibility and biomedical applications. Corrosion. Conductivity. Structure/property relationships in polymers, metals, ceramics, semiconducting materials, nanoporous materials and composites.
Course Component: Lecture
Prerequisite: CHG 2314.

CHG 3316 Transport Phenomena (3 units)
Use of fundamental chemical engineering principles to solve problems in momentum, heat and mass transfer applications. Shell momentum balances. Equations of motion, mass and energy balances to determine velocity, temperature and concentration profiles for different geometries for steady-state and transient systems. Evaluation of concentration profiles in the presence of a chemical reaction, with and without a catalyst. Evaluation of mass transfer coefficients.
Course Component: Lecture, Tutorial
Prerequisites for CHG: CHG 2312, CHG 2314, MAT 2322, MAT 2384.
Prerequisites for CVG: CVG 3132, MAT 2322, MAT 2384.

CHG 3324 Fundamentals and Applications of Chemical Engineering Thermodynamics (3 units)
First and second laws of thermodynamics. PVT behaviour of fluids. Equations of state. Thermal chemical effects. Estimation of physical-chemical properties. Applications of thermodynamics to various processes in the field of chemical engineering.
Course Component: Lecture, Tutorial
Prerequisite: CHG 2317.

CHG 3326 Principles of Phase Equilibria and Chemical Reaction Equilibria (3 units)
Properties of homogeneous mixtures. Models of solution. Fugacity and fugacity coefficient. Activity coefficient. Excess properties. Gibbs-Duhem equation and its applications. Criteria of equilibrium. Vapour-liquid equilibrium at low and high pressures. Methods of prediction. Chemical equilibrium constant, maximum conversion. Multi-reaction equilibria. Selection of operating conditions. Mathematical techniques related to the study of these topics.
Course Component: Lecture, Tutorial
Prerequisites: CHG 2324 or CHG 3324.

CHG 3331 Application of Mathematical Methods to Chemical Engineering (3 units)
The study of numerical methods common to engineering analysis and design, including methods for solving nonlinear equations and systems of equations, function interpolation and approximation, numerical integration and the solution of differential equations. Students will learn the theory behind the methods and, equally important, when and how to apply them to engineering problems.
Course Component: Laboratory, Lecture
Prerequisites: CHG 2312, CHG 2314, CHG 2317, (GNG 1106 or ITI 1120), MAT 2322, MAT 2384.

CHG 3335 Process Control (3 units)
Fundamental concepts involved in establishing the transient behaviour and control characteristics of processes. Process dynamics. Dynamics of measuring and control elements. Controller characteristics. Dynamics of control loops. Stability criteria. Multiple loop systems. Advanced control system design. Introduction to sampled-data systems.
Course Component: Lecture, Tutorial
Prerequisites: CHG 2314, CHG 2317.

CHG 3337 Data Collection and Interpretation (3 units)
Combinatorial analysis; probability and random variables; discrete and continuous densities and distribution functions; expectation and variance; normal (Gaussian), distributions; statistical estimation and hypothesis testing; method of least squares, correlation and regression. Basic principles and techniques for the efficient design of experiments and effective analysis of data. Topics include: the nature and analysis of process variability, comparing processes, blocking and randomization, empirical model building for quantifying relationships between process inputs and outputs, two-level factorial and fractional factorial designs for screening out inert input variables, other designs, a practical approach to experimental design.
Course Component: Lecture, Tutorial
Prerequisites: CHG 1125, CHG 1371, MAT 2384.

CHG 3716 Phénomènes d'échange (3 crédits)
Utilisation des principes fondamentaux de génie chimique pour résoudre des problèmes dans des applications de transfert de quantité de mouvement, d'énergie et de matière. Bilans différentiels de quantité de mouvement. Équations de mouvement, de continuité et d'énergie pour déterminer les profils de vitesse, de température et de concentration dans différentes géométries pour des systèmes en régime permanent et transitoire. Évaluation des profils de concentration en présence d'une réaction chimique avec ou sans catalyser. Évaluation de coefficients de transfert de matière.
Volet : Cours magistral, Tutoriel
Préalables pour CHG : CHG 2712, CHG 2714, MAT 2722, MAT 2784.
Préalables pour CVG : CVG 3132, MAT 2722, MAT 2784.

CHG 3724 Principes et applications de thermodynamique en génie chimique (3 crédits)
Première et deuxième lois de la thermodynamique. Comportement PVT des fluides. Équations d'état. Effets chimiques-thermiques. Évaluation des propriétés physico-chimiques. Application de la thermodynamique à divers procédés dans le domaine du génie chimique.
Volet : Cours magistral, Tutoriel
Préalable : CHG 2717.

CHG 3735 Contrôle des procédés (3 crédits)
Concepts fondamentaux impliqués lors de l'établissement des caractéristiques transitoires et du contrôle des procédés. Dynamique des éléments de mesure et de commande. Caractéristiques de contrôleurs. Dynamique des boucles de contrôle. Critères de stabilité. Systèmes de boucles multiples. Conception de systèmes de contrôle avancés. Introduction aux systèmes de données prélevées.
Volet : Cours magistral, Tutoriel
Préalables : CHG 2714, CHG 2717.

CHG 3737 Collecte et interprétation de données (3 crédits)
Analyse combinatoire, probabilités et variables aléatoires, fonctions de densité et de répartition pour les variables de type discret ou continu. Espérance mathématique et variance; distribution normale; estimation et tests d'hypothèses; méthode des moindres carrés, corrélation et régression. La théorie est illustrée par des simulations. Principes et techniques pour la conception d'expériences et l'analyse efficace des données. Les sujets traités comprennent : la nature et l'analyse de la variabilité des procédés, la comparaison de procédés, le regroupement des variables par sous-ensembles et randomisation, le développement de modèles empiriques pour quantifier les relations entre les variables d'un procédé, les plans factoriels à deux niveaux et plans factoriels fractionnaires pour filtrer les variables indépendantes non signifiantes, combinaison de plans expérimentaux, une approche pratique pour la conception d'expériences.
Volet : Cours magistral, Tutoriel
Préalables : CHG 1525, CHG 1771, MAT 2784.

CHG 4116 Chemical Engineering Laboratory (3 units)
Laboratory course to demonstrate chemical engineering principles, to further develop engineering judgment, to gain hands-on experience with equipment, and to enhance oral and written communication skills. Students participate in all phases of the investigation -- planning, execution, analysis, reporting. Use of the computer for simulation and data analysis.
Course Component: Laboratory, Lecture
Prerequisites: CHG 3122, CHG 3111, CHG 3127, CHG 3326, CHG 3335. CHG 3337 is prerequisite or corequisite to CHG 4116.

CHG 4143 Introduction to Pharmacokinetic Analysis of Drug Delivery Systems (3 units)
This survey course examines engineering analyses of biotransport processes, with special focus on pharmacokinetic modeling and drug delivery. Beginning with overviews of solute exchange within the body and the human immune system, the course will then move to the topics of pharmacokinetics and drug delivery schemes. Both general approaches to, and specific examples of pharmacokinetic models will be examined. A review of a variety of drug delivery techniques currently applied or under investigation will also be presented.
Course Component: Lecture
Prerequisites: CHG 3316, CHG 3331.

CHG 4160 Techniques in Biomedical Engineering (3 units)
Topics covered in this course are principles and techniques commonly used in biomedical engineering related to cell processing and tissue engineering, molecular biology, genetic engineering and gene therapy, biophysical chemistry, proteins and nucleic acids, and microscopy.
Course Component: Lecture
Prerequisites: 54 university units including CHG 2312, CHG 2314, CHG 2317.

CHG 4244 Plant Design Project (6 units)
A study of the engineering aspects involved in the development of an industrial plant. Capital and manufacturing cost estimates. Safety in design. Feasibility survey. Equipment design and specification. Plant layout and location. Students will work in small groups to produce a process design and economic evaluation of a complete industrial plant.
Course Component: Laboratory, Lecture
Prerequisites: 81 university units including CHG 3111, CHG 3112, CHG 3122, CHG 3127, CHG 3316, CHG 3324, CHG 3326, CHG 3331, CHG 3335, CHG 3337.

CHG 4250 Plant Design Project (9 units)
A study of the engineering aspects involved in the development of an industrial plant. Capital and manufacturing cost estimates. Safety in design. Feasibility survey. Equipment design and specification. Plant layout and location. Students will work in small groups to produce a process design and economic evaluation of a complete industrial plant.
Course Component: Laboratory, Lecture
Prerequisites: CHG 3111, CHG 3112, CHG 3122, CHG 3127, CHG 3326, CHG 3335, CHG 3337 and 54 university course units.

CHG 4301 Air Pollution Control Processes (3 units)
This course will review sources and types of air pollution and discuss design of equipment for use in air pollution control, e.g. grit and dust removal, sampling, equipment performance, mist removal in chemical processes, gas absorption processes, solid chemical absorbents and regeneration processes. Stack heights, dispersions and meteorological factors.
Course Component: Lecture
Prerequisites: 54 university units including CHG 2312, CHG 2314, CHG 2317.

CHG 4302 Environmental Biotechnology (3 units)
Significance of microorganisms in the environment. Soil and aquatic environments, extreme environments. Kinetics of microbial growth and degradation of raw materials. Continuous and batch reactors. Mass and heat transfer. Aerobic and anaerobic processes. Microbial conversion of carbon, nitrogen and other elements. Microbial corrosion. Mineral leaching with microorganisms. Composting. Microbial contributions to pollution. Use of genetic techniques to engineer organisms with novel catalytic capabilities.
Course Component: Lecture
Prerequisites: 54 university units including CHG 2312, CHG 2314, CHG 2317.

CHG 4305 Advanced Materials in Chemical Engineering (3 units)
An introduction to the fundamentals of materials science with special emphasis on materials and applications of interest to chemical engineers. Biocompatibility and biomedical applications. Corrosion. Conductivity. Structure/property relationships in polymers, metals, ceramics, semiconducting materials, nanoporous materials and composites.
Course Component: Lecture, Tutorial
Prerequisite: 81 university units.

CHG 4307 Process Risk Management and Sustainability (3 units)
Introduction to risk assessment, the law as it affects the environment and workplace safety, the biodegradability and fate of air and water emissions, mass exchange networks/pinch technology, environmental analyses of process design.
Course Component: Discussion Group, Lecture
Prerequisite: 81 university course units.

CHG 4331 Introduction to Polymer Reaction Engineering (3 units)
Principles governing polymerization reactions. Mechanisms and kinetics of step-growth and chain-growth polymerization and copolymerization. Physical properties of polymers and polymer characterization. Molecular weight distribution. Polymerization reaction engineering: mathematical modelling and polymer reactor design in industrial settings.
Course Component: Lecture
Prerequisite: 81 university units.

CHG 4343 Computer-Aided Design in Chemical Engineering (3 units)
The application of computer programming to chemical engineering process simulation and analysis. Through worked examples and assignments, students develop their skills in process modeling and simulation using a high level programming language. As part of the course, students are expected to design, develop and test their own computer-based process simulators of one or more unit operation common to the field of chemical engineering.
Course Component: Lecture, Tutorial
Prerequisites: CHG 3111, CHG 3127, CHG 3335, and 72 university course units.

CHG 4359 Selected Topics I (3 units)
Discussion of recent progress in chemical engineering.
Course Component: Lecture
Prerequisites: 54 university units including CHG 2312, CHG 2314, CHG 2317.

CHG 4360 Selected Topics II (3 units)
Discussion of recent progress in chemical engineering.
Course Component: Lecture
Prerequisites: 54 university units including CHG2312, CHG2314, CHG2317.

CHG 4361 Selected Topics III (3 units)
Discussion of recent progress in chemical engineering.
Course Component: Lecture
Prerequisites: 54 university units including CHG 2312, CHG 2314, CHG 2317.

CHG 4362 Selected Topics IV (3 units)
Discussion of recent progress in chemical engineering.
Course Component: Lecture
Prerequisites: 54 university units including CHG2312, CHG2314, CHG2317.

CHG 4364 Oil and Gas Processing (3 units)
Overview of the technologies, processes and equipment used in the characterization and processing of natural gas, crude oils and Canadian bitumen.
Course Component: Lecture
Prerequisites: 54 university units including CHG2312, CHG2314, CHG2317.

CHG 4380 Particulate and Multiphase Systems (3 units)
Principal elements in the design of various commercially important particulate processes including particle characterization and particles transport through pneumatic conveying. Design and operation of units including packed beds, fluidized beds, filters, cyclones, and thickener/clarifiers will be reviewed.
Course Component: Lecture
CHG 3111 is prerequisite or corequisite to CHG 4380.

CHG 4381 Biochemical Engineering (3 units)
Elements of applied microbiology: taxonomy, morphology of micro-organisms, cell composition and metabolism, growth kinetics and product formation. Application of chemical engineering principles to the analysis of industrial fermentation processes. Bioreactor design and downstream processing. Industrial applications of bioprocesses: food processing, pharmaceuticals, conversion of waste materials to useful products.
Course Component: Lecture, Tutorial
Prerequisites: 81 university course units including CHG 3111, CHG 3127.

CHG 4385 Adsorption Separations for Environmental Applications (3 units)
Basic principles and fundamentals of adsorption. Discussion of different important design parameters for adsorbers. Gas and vapour adsorption separation applications for environmental air pollution control. Liquid adsorption separation applications for water pollution control. Different types of designs for adsorbers are discussed.
Course Component: Lecture
Prerequisites: 54 university units including CHG 2312, CHG 2314, CHG 2317.

CHG 4780 Systèmes particulaires et multi phases (3 crédits)
Ce cours présente les principaux éléments de la conception de divers procédés particulaires d'importance commerciale, notamment la caractérisation des particules et leur transport par voie pneumatique. La conception et le fonctionnement des unités comprenant les lits garnis, les lits fluidisés, les filtres, les cyclones et les épaississeurs/clarificateurs seront examinés.
Volet : Cours magistral
CHG 3111 est préalable ou concomitant à CHG 4780.

CHG 4900 Thèse et séminaire / Thesis and seminars (6 crédits / 6 units)
Les étudiants doivent préparer une thèse et préparer un séminaire sur un sujet approuvé. Le sujet de la thèse doit être approuvé par un professeur du département qui agira à titre de directeur de thèse. / The student must prepare a thesis and present a seminar on an appoved topic. The topic must have received approval of a professor in the Department who will act as thesis supervisor.
Volet / Course Component: Laboratoire / Laboratory
Préalables : CHG 3111, CHG 3122, CHG 3127, CHG 3716, CHG 3737 et 66 crédits de cours universitaires. Une moyenne MPC minimale exigée de 6,0. / Prerequisites: CHG 3111, CHG 3122, CHG 3127, CHG 3316, CHG 3337 and 66 university course units. Must have a minimum GPA of 6.0.

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)
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)
Discussion of recent progress in chemical engineering. This course is equivalent to ENVJ 8191 at Carleton University.
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 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 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 9998 Examen de synthèse (doctorat) / Comprehensive Examination (Ph.D.)
Volet / Course Component: Recherche / Research