CHEMICAL ENGINEERING

Courses

CHEE 209 Analysis Of Process Data Units: 3.50
Statistical methods for analyzing and interpreting process data are discussed. Topics include: role of data in assessing process operation, identifying major problems, graphical and numerical summaries, principles of valid inference, probability distributions for discrete and continuous data and an introduction to linear regression analysis.
EXCLUSIONS: STAT 263, STAT 268, STAT 269, MTHE 367, STAT 367
Requirements: (APSC171 AND APSC174) OR (APSC171 AND APSC172)
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

CHEE 210 Thermodynamics of Energy Conversion Systems Units: 3.50
This course is an introduction to thermodynamics for chemical engineering systems analysis. The principles arising from First and Second laws of thermodynamics will be applied to the solution of mass, energy, and entropy balances for homogeneous closed and open systems. Properties of ideal gases and real fluids will be derived from Equations of State and applied in the analysis of simple flow processes. The students will compute efficiencies and coefficients of performance for energy production, conversion, and storage systems. The impacts of energy process design choices on efficiency, performance, and sustainability will be measured through exergy analysis.
Requirements: (APSC131 AND CHEE221) OR (APSC131 AND APSC132) OR (APSC131 AND APSC172) OR APSC131 OR (APSC131 AND APSC172) OR APSC132 OR (APSC131 AND MINE201) OR (APSC131 AND APSC132) OR APSC172
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

CHEE 218 Laboratory Projects I Units: 2.50
The projects provide a practical introduction to processes that occur in chemical engineering operations. Bench-scale and pilot plant equipment are used. Students plan and carry out the experiments, analyze the data and prepare written reports
Requirements: Prerequisites of APSC 100 (or APSC 102), CHEE 209, or permission of the instructor. and registered in a BSCE or BASC Academic Program.
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

CHEE 221 Chemical Processes And Systems Units: 3.50
Introduction to the fundamentals and principles of chemical engineering, with applications to chemical and biochemical processes, via an analysis of processing units including distillation, crystallization and combustion. Specific topics include conservation equations for mass and energy, process flow diagrams, material and energy balances, chemical reaction fundamentals, and applications of the First Law of Thermodynamics.
Requirements: APSC131, APSC132, APSC172, or permission of the department. Must be registered in a BSCE or BASC academic program.
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

CHEE 222 Process Dynamics & Num Methods Units: 3.50
Time-varying operation of chemical and biochemical processes is introduced. Dynamic mathematical models are formulated using material and energy balances. Effects of operational and design parameters on steady-state and dynamic operations are investigated. Numerical techniques are introduced to solve systems of algebraic and differential equations. Numerical and symbolic computation tools are used to analyze dynamic and steady-state process behaviour.
Requirements: APSC143 (or APSC142), CHEE221, MTHE225 (or MATH225) or permission of the department. Must be registered in a BASC academic program.
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

CHEE 223 Fluid Mechanics Units: 3.50
Principles of momentum and energy transport are applied to the analysis of fluid systems commonly encountered in chemical engineering practice. This approach is via the macroscopic and differential balances of mass, momentum and energy. Topics include fluid statics; incompressible flow in closed conduits; flow and pressure measurement; transportation of fluids; laminar, turbulent and creeping flows; boundary layer effects; sizing of commercial components (piping, tubing, valves, pressure and flow meters and other fittings, as well as pumps) for fluid transport systems in industrial settings.
Requirements: Prerequisite: CHEE221, MTHE 225 (or MATH 225)and BSCE or BASC Academic Program.
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

CHEE 224 Transport Phenomena Fundamentals Units: 3.00
The theory and mathematical framework of transport phenomena are introduced. Mass, energy and momentum balances are developed using the integral and differential methods of analysis. The tools used to formulate and solve the problems include representation of physical entities in vector form, multivariable functions and vector operations in 2D and 3D. Specific topics of Chemical Engineering interest include moments of a force, work done by a force, moments of inertia, control surfaces and control volumes and fluid kinematics.
Requirements: Prerequisites: APSC171, APSC172, and registered in the BSCE or BASC program.
Offering Faculty: Fac of Engineering Appl Sci

CHEE 229 Cell Based Engineering Princip Units: 4.00
Introduction to the Biological, Biochemical and Life Science principles of cell/enzyme based engineering systems and processes. The emphasis will be placed on microbial cell culture, but comparisons will be drawn to related systems including viral, plant and animal cell culture as it relates to medicine, industrial practice or the environment.
Requirements: CHEE229 Exclusions
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

CHEE 270 ChemEtronics Units: 3.00
This course combines elements of chemical and electrical engineering to measure, calculate and control electrical signals. The course introduces basic electrical circuit analysis theory with an emphasis on concepts utilized in analytical chemistry instrumentation and energy conversion and storage. An introduction to signal analysis, data acquisition, sampling and quantization, as well as the fundamental statistical techniques necessary to process and analyze measured data with uncertainty is given. Course content is delivered via a blended offering with on-line instruction and active learning sessions.
Offering Faculty: Fac of Engineering Appl Sci

CHEE 302 Technical Entrepreneurship Units: 3.50
This course will help learners from all disciplines develop an entrepreneurial mindset capable of turning problems into opportunities. Learners will identify sources, rates, and directions of technological change, and begin to understand the role and challenges of technological innovation across sectors, countries, and organizations. Learners will investigate the relationships between innovation and industrial dynamics, and seek to understand the fundamental forces that drive the science and technology industries' evolution and industry life cycles. In the process, learners will explore frameworks and tools used to analyze new technology adoption, predict technology diffusion patterns, and assess the strategic value of technological innovation.
Requirements: Exclusion: CHEE 310, CHEE 410
Offering Faculty: Fac of Engineering Appl Sci

CHEE 311 Fluid Phase And Reaction Equilibrium Units: 3.50
This course is concerned with the application of thermodynamics to practical problems of the chemical industry. Emphasis is placed on the study of phase equilibrium, including vapour-liquid equilibrium and liquid-liquid equilibrium. Contemporary methods of calculating the thermodynamic properties of non-ideal vapours and liquids will be presented and applied. The principles of chemical reaction equilibrium will also be studied. The design component of the course will require students to perform theoretical vapour-liquid equilibrium calculations and recommend proper operating conditions for a single-stage unit (flash drum) that separates a non-ideal binary mixture.
Requirements: Prerequisite of CHEE210 and registered in a BSCE or BASC Academic Program.
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

CHEE 315 Laboratory Projects II Units: 4.00
The main objectives are to develop skill in using process and analytical equipment, to examine the strengths, weaknesses, and limitations of current theory, to improve the student's ability to obtain and interpret data, to demonstrate the value of planning experiments, to develop engineering judgement, and to provide experience in oral and written reporting.
Requirements: Prerequisite of CHEE222 and CHEE223 and registered in a BSCE or BASC Academic Program.
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

CHEE 319 Process Dynamics & Control Units: 3.50
The dynamic behaviour and automatic control of processes are studied. Mathematical tools for analyzing the transient behaviour of open and closed-loop systems are presented. The steps of controller development are treated: process characterization (using mathematical models), controller design, and implementation. Methods for assessing system stability and performance are investigated, and are used in the design of controllers. Frequency response methods are introduced, as is the development and implementation of controller enhancements including feedforward and cascade control.
Requirements: Prerequisite: CHEE 222 or MINE 201, MTHE 225 (MATH 225), CHEE 321 or permission of the department. Must be registered in a BSCE or BASC academic program.
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

CHEE 320 Analysis Of Process Data Units: 3.50
Requirements: CHEE320 Exclusions
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

CHEE 321 Chemical Reaction Engineering Units: 3.50
This course provides a detailed and in depth analysis to the principles of chemical kinetics, and reactor analysis and design. The topics in chemical kinetics include: rate constants, reaction order, rate equations for elementary and complex reactions, kinetic data analysis, and product distribution. In reactor analysis and design, discussion is focused on ideal reactor systems and arrangements, including batch reactors, plug flow reactors, continuous stirred tank reactors, and recycle reactors. The last part of the course considers homogeneous and heterogeneous catalytic reactions. The design component consists of how to make an appropriate choice of reactor type and operating conditions to optimize a desired product; sizing such reactors and determining conversion levels under various conditions of temperature and pressure; determination of reaction kinetics from experimental data.
Requirements: (CHEE221 AND CHEE222) OR (CHEE221 AND CHEE210) OR (CHEE221 AND CHEE210) OR (CHEE221 AND CHEE222) OR (CHEE221 AND CHEE222) OR (CHEE221 AND CHEM244) OR (CHEE221 AND CHEE222) OR (CHEE221 AND CHEM244) OR (CHEM244 AND CHEE222) OR (CHEE221 AND CHEE222) OR (CHEE221 AND MINE201) OR (CHEM244 AND MINE221)
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

CHEE 323 Industrial Catalysis Units: 3.50
Students will learn, discuss and apply knowledge of the chemical structure and reactivity of industrial catalytic compounds, with particular emphasis placed upon the integration of fundamental catalytic chemistry with the principles of chemical reaction engineering, transport phenomena and thermodynamics. Industrial processes of interest include homogeneous ionic, radical, and coordinative catalytic systems, as well as heterogeneous fluid-solid systems. The design component of the course will require students to develop catalytic processes to meet productivity targets from provided kinetic and thermodynamic data.
Requirements: ENCH 245, CHEE 321, CHEE 330, or permission of the Chemical Engineering department.
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

CHEE 324 Organic Process Development Units: 3.50
Students will expand their knowledge of functional group interconversions and C-C bond forming reactions learned in ENCH 245, and apply retrosynthetic analysis to propose multi-step syntheses of organic target molecules. Selection of reagents, solvents and reaction conditions will be examined in the context of process safety, reaction yield, product isolation, and profitability. This will be followed by studies of target molecule recovery by extraction, recrystallization, distillation and chromatography. The design component of the course is a series of two-hour design challenges in which student teams generate solutions to process development problems. This includes proposing reaction sequences for producing a target molecule, conducting safety analyses of hazardous reactions, choosing from multiple synthetic routes, and recommending separation trains for product isolation. 0/12/0/10/20
Requirements: PREREQUISITES: ENCH 245 and CHEE 311. Must be registered in BSCE or BASC.
Offering Faculty: Fac of Engineering Appl Sci

CHEE 330 Heat And Mass Transfer Units: 3.50
This course follows a unified approach to introduce the physical origins and rate equations of heat and mass transfer. The principal topics covered include identification of the driving forces for heat and mass diffusion, development of transport models from first principles, steady state and transient solutions, and convective transfer. The boundary layer analogies are introduced. Closed form analytical solutions and correlations derived from dimensional analysis are used to estimate the heat and mass transfer convection coefficients.
Requirements: Prerequisite: CHEE 210 and CHEE 223, or permission of the department. Must be registered in a BSCE or BASC academic program.
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

CHEE 331 Design of Unit Operations Units: 4.50
This course is part of the Engineering Design and Practice Sequence. Heat and mass transfer knowledge is applied in the analysis and design of unit operations, including separation processes and heat exchanging equipment. The equilibrium stage concept is used to perform calculations and size separation processes including distillation, gas absorption/stripping and liquid-liquid extraction. Heat transfer processes are taught with an emphasis on the design various types of heat exchanging equipment, including shell and tube heat exchangers, condensers and reboilers. The chemical process design component of the course involves a series of activities, dealing with the design of separation processes, heat exchanger sizing and design, process hazards analysis, implementation of instrumentation and construction of piping and instrument diagrams. In addition to choosing and sizing unit operations and implementing appropriate process instrumentation, the students will learn to use simulation tools and will incorporate economics, safety and environmental responsibility in all stages of the design. The course is integrated with CHEE 361 "Engineering Communications, Ethics and Professionalism."
Requirements: APSC 200 or APSC 202, APSC 293, CHEE 311, CHEE 321, CHEE 330, or permission of the Department. Corequisite: CHEE 361.
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

CHEE 340 Biomedical Engineering Units: 3.50
This course will provide students with a fundamental understanding of cell biology, human physiology and the application of engineering principles (momentum and mass transfer, mechanics, materials) for the solution of medical problems. Topics include: Cell Biology, Anatomy and Physiology, Transport Phenomena in the Body, Biomechanics, Materials in Medicine, and Regenerative Medicine and Tissue Engineering.
Requirements: Excl: CHEE442 MECH 394. Must be enrolled in BASC
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

CHEE 342 Environmental Biotechnology Units: 3.50
This course gives a broad perspective of the use of microbial systems to treat environmental pollutants and of microorganisms as potential environmental contaminants. Biogeochemical cycles and their applications to processes such as the desulphurization of coal and crude oil, biocorrosion, mineral (eg. uranium, copper and iron) leaching, the degradation of organic compounds, and nitrate removal from drinking water will be studied. Microbial waste disposal systems such as composting and soil bioremediation and the role of biotechnology in waste minimization will be examined. Microorganisms found in air, soil and water, their detection, enumeration and control will be discussed.
Requirements: Registered in BSCE or BASC
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

CHEE 361 Engineering Communications, Ethics & Professionalism Units: 1.00
This course provides advanced instruction and practice in engineering communications, engineering ethics and professionalism. Effective engineering writing and speaking skills are developed with an emphasis on engineering reports and oral presentations. Students will learn how to gather information, apply appropriate citation styles, write effective documents, and present data effectively. Activities include case studies involving the application of codes, engineering ethics, equity and professionalism. This course is integrated with CHEE 331.
Requirements: Prerequisite: APSC 200 or APSC 202, APSC 293 or permission of the Department. Corerequisite: CHEE 331 or permission of the Department.
Offering Faculty: Fac of Engineering Appl Sci

CHEE 363 Electrochemical Engineering Units: 3.50
This engineering science course covers aspects of technological applications of electrochemistry. It can be considered as overlap between electrical engineering, electrochemistry and chemical engineering. The course addresses the following 7 major topics of electrochemical engineering: 1) Introduction into Electrochemical Engineering and Systems: Characteristics, Charge Conservation, Faraday¿s Law; 2) Elements of Electrochemical Systems I. Electrolytes: Transport processes, electrolyte conductivity, pH and buffer solutions; 3) Elements of Electrochemical Systems II. Electrodes: Electrochemical Thermodynamics, Nernst Equation, Reference Electrodes, Cell Potential, Electrochemical Kinetics; 4) Electrical Double Layers: Theory & Models, Electrokinetic Phenomena; 5) Electrochemical Characterization Methods: Cyclic Voltammetry, Electrical Impedance Spectroscopy; 6) Electrochemical Energy Engineering: Batteries, Fuel Cells, Electrical & Electrochemical Capacitors; 7) Industrial Electrochemical Processes: Fundamentals, Reactor Design & Parameter, Chlor-Alkali Process, Electrochemical Extraction of Metals, Hall-Heroult Process.
Requirements: (CHEE210, CHEE270, AND CHEE321)
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

CHEE 371 Mitigation of Industrial Pollution Units: 3.50
Sources and characteristics of waste streams emanating from chemical and related industries are reviewed as the basis for developing appropriate abatement and treatment strategies. Treatment processes utilizing individual operations as well as integrated systems of physical, chemical and biological treatment are covered. Treatment process designs and sensitivity analyses of alternatives are undertaken for case studies involving industrial solid, liquid and gaseous wastes. Canadian guidelines and regulations are presented and implemented within the context of environmental and human health.
Requirements: Prerequisite: CHEE 221 or MINE 221, or permission of the Department.
Offering Faculty: Fac of Engineering Appl Sci

CHEE 380 Biochemical Engineering Units: 3.50
Biochemical Engineering involves the application of Chemical Engineering principles and approaches to biologically-based systems and processes. Biochemical Engineering is central to the area of environmental engineering, and to biotechnology processes which produce pharmaceuticals, fine chemicals and genetically engineered products. The course involves a systematic and quantitative description of medium formulation and sterilization, microbial kinetics and bioreactor design, product isolation and purification, and examples of current industrial practices and processes.
Requirements: Prerequisite: CHEE 221 or permission of the Chemical Engineering department. Must be registered in a BSCE or BASC program.
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

CHEE 390 Polymer Forms & Proc Tech Units: 3.50
Requirements: CHEE223 OR MECH241
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

CHEE 400 Technology, Engineering & Management (TEAM) Units: 7.00
Multidiscipline teams of engineering, commerce, law, and/or science students, as appropriate, act as consultants to industrial and governmental clients. Projects include a phase of self-directed problem definition and project scope definition in the fall term, followed by project execution in the winter term. Typical projects involve evaluation of technical alternatives (with an emphasis on health, safety, and environmental), preparation of detailed recommendations, and both market and financial analysis. Project topics vary widely and are provided by a diverse list of fee paying clients. The course includes seminars on project management. There are several meetings during the fall term to organize groups and select projects, but regularly scheduled lectures do not begin until the Winter term. Teams interact regularly with clients at both a technical and a management level, and are also assigned an industrial project mentor. Students master project management skills, by managing their own budget, travel arrangements etc. The course concludes with a comprehensive report and presentation to the client. The course is managed by the Department of Chemical Engineering
Requirements: Prerequisite: Permission of the Instructor. Must be registered in BASC or BSCE.
Offering Faculty: Fac of Engineering Appl Sci

CHEE 408 Bioengineering Research Project Units: 7.00
Students will conduct research on a Biochemical/Biomedical/Bioenvironmental Engineering related project. Based on the project objective provided by their faculty supervisor, the students will work independently to develop an experimental and/or modeling methodology, conduct experiments or simulations and generate data. Students will submit interim oral and written progress reports and a final oral presentation and technical report. They will be expected to present and defend their results in a conference/seminar setting. Students enrolling for this course are advised to consult with the faculty member supervisor concerned late in the winter term of their 3rd year of study.
Requirements: Must be registered in BASC
Offering Faculty: Fac of Engineering Appl Sci

CHEE 410 Technical Entrepreneurship Units: 3.50
Requirements: APSC 221 and Registered in BASC Academic Program Exclusions: CHEE 302, CHEE 310
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

CHEE 412 Transport Phenomena Units: 3.50
The transport phenomena approach is followed to study and analyze transport of momentum, energy and mass, with special focus on combined transport problems. Solutions are developed for problems involving steady-state and unsteady flows, isothermal and non-isothermal conditions, as well as non-Newtonian liquids. This course completes the students' intellectual training in the transport sciences culminating in their mastery of combined transport problems, including fluid flow with heat transfer, or mass transport with fluid flow, or heat transfer with mass transport.
Requirements: Prerequisite of CHEE 223, CHEE 224, CHEE 330, or permission of the Department. Must be registered in a BSCE or BASC Academic Program.
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

CHEE 414 Foundations of the Oil and Gas Industry Units: 3.50
Fundamentals of the oil and gas industry covering Chemical Engineering and Geological Engineering practice, and implications of Canadian and world political forces together with business practices are covered. Industry needs for exploration, recovery, processing, business expansion and policy issues will be addressed through case studies, in conjunction with examination of suitable business models.
Requirements: CHEE 221 or permission of inst
Offering Faculty: Fac of Engineering Appl Sci

CHEE 415 Engineering Chemistry Laboratory Units: 4.00
Bench- and pilot-scale laboratory exercises provide students practical experience with chemical operations involving transport phenomena, thermodynamics, reaction kinetics and process control. Working with minimal supervision, student teams plan and execute experiments, analyze acquired data according to engineering science models, and communicate key findings in concise technical reports.
Requirements: CHEE 330
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

CHEE 418 Strategies Proc Investigations Units: 3.50
"The roles of designed experiments and data analysis procedures in process investigations are discussed. Applications of two-level factorial and fractional factorial designs in screening studies and higher-order designs for response surface characterization and exploration are examined. Least squares procedures for fitting and testing mathematical models, and for assessing model predictions, are described.
Empirical in-plant optimization procedures are also considered. Established and evolving approaches for quality and productivity improvement are examined. The design component of this course is the planning and execution of an experimental investigation, the analysis of the resulting data, and the formulation of recommendations on the basis of those results."
Requirements: Exclusion: STAT361. Prerequisite of CHEE209 and CHEE 331, or permission of the department. Must be registered in a BASC Academic Program.
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

CHEE 420 Laboratory Projects III Units: 4.00
Students will work as teams to tackle projects that require bench and pilot plant equipment, and computer packages that simulate commercial processes. The projects will be more extensive and integrated than in previous laboratories, and will require a thorough and comprehensive analysis of processes and operations. A strong emphasis is placed on project planning and management, as well as professional communication with supervisors. The design component of this course is found in the application of process analysis skills to solve problems. The projects require the students to apply critical and problem solving skills in the operation or simulation of laboratory and process equipment with the goal of solving a problem for a fictitious industrial client. The projects may involve analysis or troubleshooting of existing equipment, or an investigation of the applicability of a concept to a new area.
Requirements: Prerequisite CHEE 311, CHEE 315, CHEE 319, CHEE 321, CHEE 330, or permission of the department. Must be registered in a BSCE or BASC academic program.
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

CHEE 421 Research Project Units: 7.00
This course provides an opportunity for students to work on an individual basis with faculty members of the department. Students will submit interim oral and written progress reports and a final oral presentation and technical report. They will be expected to present and defend their results. The projects may be concerned with engineering design and development work or may be of a more fundamental research nature. Students enrolling for this course are advised to consult with the faculty member concerned late in the winter term of their 3rd year of study. (0/0/28/0/56)
Requirements: Must be registered in BASC
Offering Term: FW
Offering Faculty: Fac of Engineering Appl Sci

CHEE 434 Process Control II Units: 3.50
This course presents methods for dynamic analysis and controller design for multivariable process control problems, and discrete time control. Control techniques, including feedforward and cascade control, are discussed further, and the concept of model predictive control is presented. Multivariable controller design and the problem of control loop interaction are examined. State space models for processes are introduced. Mathematical tools for analyzing the dynamics of sampled data systems are developed, and the design of discrete time controllers is introduced. Techniques discussed in the course are applied to the control of various chemical process units.
Requirements: CHEE319
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

CHEE 440 Pharmaceutical Technology Units: 3.50
Pharmaceutics and the industrial manufacture of pharmaceutical dosage forms are introduced. Topics include the design and preparation of a successful dosage form with respect to the route of administration, and large scale manufacture in a sterile and clean environment. Aspects of chemical kinetics, physical chemistry, physiology, cell biology, mass and heat transfer, and fluid dynamics will be described as they relate to the manufacture of effective dosage forms. This course applies engineering concepts, such as mass transfer, unit operations, thermodynamics, and basic chemistry and is recommended for students in their 3rd or 4th year of studies.
Requirements: Must be registered in BASC
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

CHEE 450 Engineering Biology Units: 3.50
Topics include: biosynthesis of biologically based products: properties of biologically active materials including enzymes, polynucleotides and polypeptides; enzyme reaction kinetics; cell and tissue growth and production kinetics; cell and tissue culture engineering; diffusion and reaction involved immobilized cells and enzymes; bioprocess instrumentation. The course project will require the design of a biological reactor or downstream unit operation, or the specification of instrumentation for a particular bioprocess.
Requirements: Prerequisite of ENCH245 and registered in a BSCE or BASC Academic Program.
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

CHEE 452 Transport Phenomena in Physiological Systems Units: 3.50
This course applies the principles of mass, momentum and heat transfer in physiological systems. The students will examine the role of transport phenomena in the function of organs and organ systems in the body, and develop the skills necessary to analyze models of biological transport processes in the context of the design of biomedical devices.
Requirements: Prerequisite: CHEE 223 and CHEE 330, or permission of the department. Must be registered in a BSCE or BASC program. Exclusion: CHEE 412
Offering Faculty: Fac of Engineering Appl Sci

CHEE 460 Appl Surface & Colloid Science Units: 3.50
The course covers four major topics. 1. The thermodynamic properties of interfaces (surface energy, wetting, surface area and porosity, capillary effects, work of adhesion/cohesion). 2. Models of adsorption/desorption phenomena. 3. The amphiphilic behaviour of surfactants. 4. The stability and characterization of colloidal systems. Student appreciation for the importance of these phenomena is cultivated using examples drawn from industrial processes/products including inks, paints, foods, polymer blends, and nanocomposites.
Requirements: CHEE 210, or permission of the department. Must be registered in a BASC program.
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

CHEE 463 Electrochemical Energy Systems Units: 3.50
This engineering science and design course examines and analyzes electrochemical energy generation, conversion and storage technologies of emerging importance to modern society. Methods of generating electrical power will be examined in terms of efficiency, cost, environmental footprint, greenhouse gas emissions and current and potential applications. Integration of these power generation systems with energy conversion and storage technologies be assessed in terms of their compatibility with the supply and demand model of the electricity grid and their potential for use in remote off-grid communities. The electrification of transportation technologies will also be examined. The design element of this course involves hands-on prototyping of an integrated energy system for a specified application.
Requirements: Prerequisite: CHEE 363 and registered in BASC
Offering Faculty: Fac of Engineering Appl Sci

CHEE 471 Chemical Process Design Units: 7.00
This capstone course integrates skills, knowledge and experience gained from engineering science components of the Chemical Engineering and Engineering Chemistry curriculum to solve open-ended chemical process design problems. Students will develop competency in the following: process hazard analysis, appropriate use of process simulation techniques, identification and mitigation of process inefficiencies and risks, strategies for acquiring technical data, and cost estimation of process revisions.
Offering Term: FW
Offering Faculty: Fac of Engineering Appl Sci

CHEE 481 Air Quality Management Units: 3.50
Fluid-particle systems and mass transfer principles are presented with application to air pollution control in industrial processes. The selection and design of equipment for the control of particulate and gaseous emission sources are examined. The problem of odorous emissions, stack sampling techniques and dispersion calculations are discussed.
Requirements: One of CHEE 223, CIVL 250, or MECH 241, or permission of the department. Must be registered in a BSCE or BASCacademic program.
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

CHEE 484 Bioremediation Units: 3.50
Bioremediation as an option to treat contaminated soils and ground water. Advantages and disadvantages of bioremediation compared to nonbiological processes. Factors affecting choice of in situ or ex situ processes. Assessment of biodegradability; biostimulation vs bioaugmentation; mineralization vs. partial degradation; factors affecting microbial activity (choice of electron acceptor, toxicity of pollutant, C/N/P ratio, co-substrates, soil humidity, pH and temperature); bioavailability of pollutant. Biodegradation of specific contaminants (e.g. diesel fuel, polychlorinated biphenyls, dyestuffs, aromatic and polyaromatic hydrocarbons) will be studied in detail. The design component of this course consists of learning design of appropriate laboratory and field experiments to obtain data on microbial degradation of an organic pollutant to be able to calculate bioremediation design parameters such as mass and delivery rate requirements of electron acceptors and nutrients and degradation rates in reactor and non-reactor based systems; and to be aware of limitations of these calculations.
Requirements: Must be registered in BASC
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

CHEE 490 Polymer Forms & Proc Tech Units: 3.50
The design and manufacture of polymer products is reviewed, with particular emphasis on material selection and processing technology. The engineering properties of elastomers, thermoplastics, adhesives, fibres and coatings are discussed in terms of processing characteristics and end-use performance. Industrial processing operations such as extrusion, molding, mixing and film manufacture are presented in detail. The design component of the course requires students to select appropriate materials and processing methods for an engineering application. Examples include medical catheters, engine gaskets, drug capsules and biodegradable packaging.
Requirements: CHEE223 OR MECH241
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

CHEE 801 Strategies For Process Invest. Units: 3.00
The statistical design of experiments and the analysis of data in process investigations are considered. Empirical modelling of process behaviour is studied. Applications of factorial and fractional factorial experimental designs in screening studies and methods of response surface exploration are examined. Traditional North American approaches to quality and productivity improvement are compared with those practiced in Japan. (Jointly offered with CHEE-418, with additional assignments.) P.J. McLellan or M. Guay
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

CHEE 803 Transport Phenomena Units: 3.00
Basic concepts, generalized control volume analysis and balance equations. Constitutive equations, kinetic models, thermodynamic considerations, and prediction equations for transport properties. Coupled transport processes: Onsager's theory; forced diffusion; and thermo-chemical, thermo-electric, and electro-chemical effects. Special phenomena in biological and macromolecular systems. Phenomena at surfaces. Effects of flow and chemical reaction. Analogies between energy, material and momentum transport. Examples in the analysis of complex problems. E.W. Grandmaison
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

CHEE 807 Current Topics In Chemical Eng Units: 3.00
Selected topics in chemical engineering including chemical reaction engineering, combustion, biochemical engineering, process control, environmental engineering, applied statistics, polymer reaction engineering, polymer processing, fluidization and turbulence. Only topics not covered in other graduate courses will be included. Topics will vary depending on the instructor(s). Course coordinator: TBA.
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

CHEE 809 Colloid & Surface Phenomena Units: 3.00
The course provides in-depth coverage of the fundamentals of colloidal interactions (e.g., stabilisation, adsorption, self-assembly) and the techniques currently applied for their assessment. Current and emerging colloids-related technologies, with emphasis on nano-scale engineering (self- and directed-assembly of nanostructured materials, photonic crystals, sensors) will also be covered.Three term-hours; A. Docoslis
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

CHEE 810 Fuel Celly Systems : Design and Analysis Units: 3.00
The course will examine the design of fuel cell systems for a variety of applications ranging from large multi-megawatt stationary power systems to milliwatt scale portable electronics systems. Examples will be drawn from actual demonstration and pre-commercial prototype systems operating on a range of fuels including conventional hydrocarbons with integrated external fuel processing subsystems, anaerobic digester gas with external clean-up and preprocessing, natural gas fuelled systems with direct and indirect reforming, direct methanol fuel cells and hydrogen fuel cells. The design of combined heat and power systems (CHP) for large scale industrial applications and for small-scale residential applications will also be examined. In each of these case studies the impact of system configuration and individual component performance on efficiency will be examined and strategies for optimizing performance and minimizing complexity will be developed. In addition, the effect of system design on greenhouse gas emissions will be considered. The course will consist of three design projects of increasing complexity and a final examination. Students will be expected to give a presentation on their final design project. Three term-hours; B. Peppley.
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

CHEE 811 Math Modeling Of Chem. Process Units: 3.00
The steps that are required to build comprehensive mathematical models are examined. These steps include: definition of the intended model use and user requirements; formulation of model equations; determination of model parameters from correlations and experimental data; parameter sensitivity and estimability analysis; solution of model equations using numerical techniques; model validation; and potential model applications. While the focus is on the development of fundamental models, empirical modeling techniques are also discussed. Process examples are selected from: reactive distillation, polymerization, bioreactors, heat exchangers, and fuel cells. Students complete a mathematical modeling project related to their research interests. K.B. McAuley. Not Offered 2007-2008.
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

CHEE 813 Advanced Topics In Chem. Eng. Units: 3.00
Offering Faculty: Fac of Engineering Appl Sci

CHEE 817 Statistical Thermodynamics Units: 3.00
Offering Term: FW
Offering Faculty: Fac of Engineering Appl Sci

CHEE 818 Radiative Heat Transfer Units: 3.00
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

CHEE 820 Topics In Advanced Process Control Units: 3.00
Today, due to advances in computers, massive amounts of data are collected. These data are very difficult to be analyzed with classical statistical techniques due to the large number of variables and the interrelated nature among these variables. Multivariate statistical methods are employed for the analysis of these data in a wide spectrum of sciences such as Business Economics, Sociology, Chemical Engineering, Biology, and Medicine among others. The course will cover topics of basic Multivariate Analysis such as multivariate mean and variance analysis, T-Hotelling, Multinormal and Wishart distributions, and multivariate linear regression. Emphasis will be given in two advanced multivariate methods: Principal Component Analysis and Partial Least Squares. PCA and PLS are considered among the best statistical methods to analyze multivariate data and extract the information that is contained in them. In depth analysis of these techniques will be provided both from a theoretical and a practical point of view. The aim of the course is to provide the statistical depth and understanding of these multivariate techniques for their successful application in data analysis, and their extension in the areas of Process Monitoring, Product Development, and Image Analysis. Participants need to have knowledge of basic statistics (probability, hypothesis testing) and matrix algebra and are encouraged to bring their own data sets. This is the best way for participants to relate the new statistical techniques into their own work experience. Three term-hours; P. Nomikos
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

CHEE 821 Process Control II Units: 3.00
This is a second course in process control techniques. Topics covered will include: frequency response methods for stability analysis and controller design, deadtime compensation (e.g., Smith predictor), feedforward/ cascade control, the Internal Model Control formulation, introduction to multivariable control, and interaction analysis using the concept of relative gain. Specific applications to chemical processes will be presented. (Offered jointly with CHEE-434, with additional lectures and assignments.) M. Guay or P.J. McLellan
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

CHEE 822 Model-Based Control Units: 3.00
The course focuses on the use of explicit process models for multi-variable controller design. Linear and nonlinear control approaches are discussed in both discrete and continuous time formulations. Stability, performance and robustness issues are addressed. The role of observers for state estimation is considered. M. Guay
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

CHEE 827 System Optimization Units: 3.00
A survey of optimization problems is made and mathematical procedures for their solutions are discussed. Comparisons of optimization techniques for various classes of problems are made using industrial examples and computer studies. Both linear and nonlinear programming methods are studied. Topics include the role of optimization, definitions of objective functions and constraints, conditions for existence of an optimum; one-dimensional strategies; analytical procedures for unconstrained and constrained multi-dimensional problems, numerical procedures for unconstrained and constrained multidimensional problems, introduction to multistage optimization. M. Guay
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

CHEE 828 Polymer Reaction Engineering Units: 3.00
The fundamentals of polymerization kinetics are reviewed. The equations for batch and continuous flow reactors are developed and used in the calculation of polymerization rate and polymer quality measures. Process parameters which affect reaction rate, chain composition and molecular weight distribution are examined, and the design of polymer reactor systems is discussed. Consideration is also given to the problems of reactor design in heterophase polymerization. M.F. Cunningham or R.A. Hutchinson
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

CHEE 829 Kinetic Mechanisms Units: 3.00
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

CHEE 838 Pollution and Risk Assessment Units: 3.00
Chemicals of potential concern and their effects on human health and the environment are investigated. Principles of quantitative risk assessments are presented ¿ including hazard identification, dose-response assessment, exposure, and risk characterization ¿ in the context of regulations and applications in environmental engineering practice, addressing issues facing all stakeholders. (3.0 credits units. Term course delivered in one 12-week semester, 3 hours/ week).
Prerequisite: undergraduate level chemistry course.
Exclusion: RMC course CC541 Toxicology and Risk Assessment
Offering Faculty: School of Graduate Studies

CHEE 872 Polymeric Biomaterials Units: 3.00
This course is designed to appeal to students in all fields of this interdisciplinary field, from biomechanics to polymer chemistry. It will provide a thorough background in the underlying fundamental biological and polymer science principles involved in the use of polymers as medical materials. Topics include surface and bulk polymer properties, applications of polymeric biomaterials, the biological principles that dictate host response to a material, and biopolymer degradation. B.G. Amsden
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

CHEE 874 Tissue Engineering Units: 3.00
This course is designed as a graduate level introductory course in tissue engineering: the interdisciplinary field that encompasses biology, chemistry, medical sciences and engineering to design and fabricate living systems to replace damaged or diseased tissues and organs. Topics to be discussed include: tissue anatomy, basic cell biology, cell scaffolds, cell sources and differentiation, design considerations, diffusion and mass transfer limitations, effects of external stimuli, bioreactors, methods used to evaluate the engineered product(s), and implantation. Case studies of specific tissue engineering applications will also be discussed. Students will be required to participate in as well as lead discussions on the course material as well as relevant journal articles. No previous background in biology is required. Three term hours: S.D. Waldman
Offering Faculty: Faculty of Arts and Science

CHEE 884 Bioremediation Units: 3.00
Bioremediation as an option to treat contaminated soils, ground water, fresh water and the marine environments. Advantages and disadvantages of bioremediation compared to nonbiological processes. Factors affecting choice of in situ or ex situ processes. Assessment of biodegradability; biostimulation vs. bioaugmentation; mineralization vs. partial degradation; factors affecting microbial activity (choice of electron acceptor, toxicity of pollutant, C/N/P ratio, co-substrates, soil humidity, pH and temperature); bioavailability of pollutant. Biodegradation of specific contaminants (eg. Diesel fuel, polychlorinated biphenyls, dyestuffs, aromatic and polyaromatic hydrocarbons) will be studied in detail. This course is co-taught with CIVL-889.
EXCLUSION: CIVL-889.
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

CHEE 886 Computational Systems Biology Units: 3.00
Computational systems biology offers tools to predict and design cell behavior for bioengineering. Students will learn how to reconstruct a genome-scale metabolic network, analyze it with matrix decomposition, compute cell phenotypes (metabolism, proteome allocation, stress response), and contextualize big data in networks using machine learning. (3.0 credit units).
PREREQUISITE: permission of the instructor.
Offering Faculty: School of Graduate Studies

CHEE 887 Cellular Bioengineering Units: 3.00
This course will focus on applied cellular and molecular biology for the development of cell-based therapeutics in regenerative medicine. Emphasis will be placed on how engineering principles can be applied, in combination with an understanding of mammalian morphogenesis and physiology, to control and manipulate cellular responses in vitro and in vivo.
Offering Faculty: School of Graduate Studies

CHEE 897 Chemical Eng. Seminar Units: 6.00
Graduate students working on theses must give a seminar on their research. The seminar carries no course credit but all graduate students are required to attend.
Offering Faculty: School of Graduate Studies

CHEE 898 Master's Project Units: 6.00
Offering Term: S
Offering Faculty: Fac of Engineering Appl Sci

CHEE 899 Master's Thesis Research Units: 6.00
Offering Term: FWS
Offering Faculty: Fac of Engineering Appl Sci

CHEE 901 Polymer Rheology Units: 1.50
Rheology provides a valuable tool for the assessment of the processability of polymers in various operations, as well as the identification of their structure. This 6 week (3 hours/ week) module will discuss the fundamental relations between the rheology and structure of polymers and the principles of rheometry. M. Kontopoulou (0.25 weight)
Offering Term: N
Offering Faculty: Fac of Engineering Appl Sci

CHEE 903 Dispersed Phase Polymerisation Units: 1.50
This is a product-focused course that will include use different (non-polyolefin) concrete examples to help the students understand the reasons for producing polymer in dispersed media, the types of product one can make and the relationship between process operation and polymer structure. Emphasis is placed on reactor design, advanced modelling of dispersed phases systems, and issues related to industrial production such as characterisation, scale-up and control. T. McKenna (0.25 weight)
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

CHEE 905 Advanced Chemical Engineering Thermodynamics and Applications Units: 1.50
This module presents fundamentals of thermodynamics and advanced applications relevant in Chemical Engineering. The calculus of thermodynamics, equilibrium and stability criteria are derived. Properties of real fluids and mixtures are established. Statistical foundations are introduced, and the thermodynamics of polymers, electrochemical systems, and biological systems are presented. (1.5 credit units)
PREREQUISITES: CHEE 210 and CHEE 311 or equivalent (or permission from the instructor).
Offering Faculty: Fac of Engineering Appl Sci

CHEE 907 Current Topics in Chemical Engineering Units: 1.50
Selected topics in chemical engineering including chemical reaction engineering, combustion, biochemical engineering, process control, environmental engineering, applied statistics, polymer reaction engineering, polymer processing, fluidization and turbulence. Only topics not covered in other graduate courses will be included. Topics will vary depending on the instructor(s).
Gas-Solid Reactions
This course will focus on thermodynamics and kinetics for gas-solid reactions. The main focus of the course will be understanding what information quantum chemistry (density functional theory or DFT) computations yield and how to build thermodynamic functions and kinetic models using DFT-generated energetics. Three term-hours; K. Karan.
Offering Faculty: School of Graduate Studies

CHEE 909 Colloid and Surface Science Fundamentals Units: 1.50
Various established theories on Colloids (e.g., DLVO, XDLVO) will be analyzed and subsequently used as tools towards the understanding and prediction of phenomena relevant to contact angles, surface wetting, emulsion or particle dispersion stability, and surfactant self -assembly. Exclusion: ENCH 460.
Requirements: CHEE 909: Exclusion of ENCH 46
Offering Faculty: School of Graduate Studies

CHEE 910 Special Topics in Colloid and Surface Phenomena Units: 1.50
This course provides an in-depth examination of selected topics in colloids of great interest to sciences and technology, such as emulsion stability, adsorption, particles electrokinetics and light scattering. In-class discussions and presentations, literature reviews, and individual projects, will provide graduate students with the solid fundamental knowledge and critical thinking required to approach problems related to these phenomena in a rigorous manner. This is not intended to be an introductory course in Colloids. Prior knowledge of Colloids and Surface Science principles is required.
Prerequisites: ENCH 460, or CHEE 909 or other introductory course in Colloids, or permission of instructor.
Requirements: CHE 910 Prereq ENCH460 or CHEE
Offering Faculty: School of Graduate Studies

CHEE 911 Microscale Transport Phenomena Units: 1.50
This 6 week (3 hours/week) module will provide in-depth coverage of microscale transport phenomena motivated by the emerging fields of Microfluidics and Lab-on-a-Chip. During this course, students will intensify and expand their knowledge of the fundamentals of heat, mass, charge and momentum transfer with emphasise on microscale geometries. The difference of macro- and microscale transport phenomena and the limitation of classical mechanics will be highlighted by scaling analysis. Additionally, an introduction into the fundamentals of selected electrohydrodynamic phenomena will be given. (1.5 credit units).
Offering Faculty: Fac of Engineering Appl Sci

CHEE 912 Applied Lab-on-Chip Technologies Units: 1.50
This 6 week (3 hours/week) module will provide an overview on the latest developments, fabrication techniques, and principles of operation of contemporary micro- and nanotechnologies used in lab-on-chip (LOC) type platforms. Small-scale subunit operations required in LOC systems, equally relevant across several disciplines in both life sciences and engineering fields, will be covered in detail. The knowledge acquired in these topics will be used during the last part of the course to analyze the design of LOC-based systems in key applications in different areas including biosensing, biotechnology and emerging energy technologies. PREREQUISITE: CHEE-911, or permission of instructor (1.5 credit units)
Offering Faculty: Fac of Engineering Appl Sci

CHEE 927 Global Optimization Units: 1.50
This 6-week course introduces global optimization principles and methods for nonconvex continuous or mixed-integer programs, which can arise from a wide range of process systems engineering problems. The course consists of three parts. The first part discusses convex sets, convex functions, and Lagrangian duality theory. The second part introduces classical branch-and-bound based global optimization methods, along with convex relaxation and domain reduction techniques. The third part gives an overview of decomposition based large-scale global optimization. This course, although placed in the Department of Chemical Engineering, is designed for graduate students from across Queen's University. (1.5 credit units). PREREQUISITES: CHEE-827* or permission of the instructor.
Offering Faculty: Fac of Engineering Appl Sci

CHEE 990 Structure-Property Relationships of Polymeric Materials Units: 1.50
This six-week graduate module provides students with background in physical polymer science as it relates to the formulation of materials to satisfy engineering applications. Starting from the characterization of molecular weight and composition distributions, the fundamentals of phase transitions, solubility, adhesion and thermo-oxidative stabilization are discussed. Offered jointly with CHEE 490; S. Parent.
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

CHEE 991 Polymer Processing & Rheology Units: 1.50
This six-week graduate module examines polymer processing operations. Specific topics include extrusion and injection moulding, modeling approaches, polymer blends and composites. Particular emphasis is placed on the analysis of polymer flow. Principles of the rheology of thermoplastic melts and rheometry are presented. (1.5 credit unit weight). +++ Note this course is 1.5 credit units+++++++++++++++
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

CHEE 992 Polymeric Biomaterials Units: 1.50
This six-week graduate module provides a thorough background in the underlying fundamental biological and polymer science principles involved in the use of polymers as medical materials. Three term hours; B. Amsden
Offering Faculty: School of Graduate Studies

CHEE 999 Ph.D. Thesis Research Units: 6.00
Offering Term: FWS
Offering Faculty: Fac of Engineering Appl Sci