ENGG*6000 Advanced Heat and Mass Transfer Unspecified [0.50]
Department(s): School of Engineering
Location(s): Guelph

ENGG*6010 Assessment of Engineering Risk Unspecified [0.50]
The question of "how safe is safe enough?" has no simple answer. In response, this course develops the bases by which we can assess and manage risk in engineering. Course deals with fate and transport issues associated with risk, as relevant to engineering and how these aspects are employed in the making of decisions.
Prerequisite(s): STAT*2040 or STAT*2120
Department(s): School of Engineering
Location(s): Guelph

ENGG*6020 Advanced Fluid Mechanics Unspecified [0.50]
Department(s): School of Engineering
Location(s): Guelph

ENGG*6030 Finite Difference Methods Unspecified [0.50]
Numerical solution of partial differential equations of flow through porous media; flow of heat and vibrations; characterization of solution techniques and analysis of stability; convergence and compatibility criteria for various finite difference schemes.
Department(s): School of Engineering
Location(s): Guelph

ENGG*6040 Finite Element Methods Unspecified [0.50]
Department(s): School of Engineering
Location(s): Guelph

ENGG*6050 Engineering Systems Modelling and Simulation Unspecified [0.50]
A study of theoretical and experimental methods for characterizing the dynamic behaviour of engineering systems. Distributed and lumped parameter model development. Digital simulation of systems for design and control.
Department(s): School of Engineering
Location(s): Guelph

ENGG*6060 Medical Imaging Unspecified [0.50]
Digital image processing techniques including filtering and restoration; physics of image formation for such modalities as radiography, MRI, ultrasound. Offered in conjunction with ENGG*4660. Extra work is required for graduate students.
Prerequisite(s): ENGG*3390
Restriction(s): Credit may be obtained for only one of ENGG*4660 or ENGG*6070.
Department(s): School of Engineering
Location(s): Guelph

ENGG*6070 Optimization Techniques for Engineering Unspecified [0.50]
This course serves as a graduate introduction into combinatorics and optimization. Optimization is the main pillar of Engineering and the performance of most systems can be improved through intelligent use of optimization algorithms. Topics to be covered: Complexity theory, Linear/Integer Programming techniques, Constrained/Unconstrained optimization and Nonlinear programming, Heuristic Search Techniques such as Tabu Search, Genetic Algorithms, Simulated Annealing and GRASP.
Department(s): School of Engineering
Location(s): Guelph

ENGG*6080 Food and Bio-Process Engineering Unspecified [0.50]
Kinetics of biological reactions, reactor dynamics and design. Food rheology and texture; water activity and the role of water in food processing; unit operations design-thermal processing; and drying, freezing and separation processes.
Department(s): School of Engineering
Location(s): Guelph

ENGG*6090 General Topics in Engineering Unspecified [0.50]
A course of directed study involving selected readings and analyses in developing knowledge areas which are applicable to several of the engineering disciplines in the School of Engineering.
Department(s): School of Engineering
Location(s): Guelph

ENGG*6100 Optimization Techniques for Engineering Unspecified [0.50]
Computer vision studies how computers can analyze and perceive the world using input from imaging devices. Topics covered include image pre-processing, segmentation, shape analysis, object recognition, image understanding, 3D vision, motion and stereo analysis, as well as case studies.
Department(s): School of Engineering
Location(s): Guelph

ENGG*6110 Fermentation Engineering Unspecified [0.50]
Modelling and design of fermenter systems. Topics include microbial growth kinetics, reactor design, heat and mass transfer. Instrumentation and unit operations for feed preparation and product recovery. Prerequisite: undergraduate course in each of microbiology, heat and mass transfer, and biochemistry or bioprocess engineering.
Department(s): School of Engineering
Location(s): Guelph

ENGG*6120 Physical Properties of Biomaterials Unspecified [0.50]
Rheology and rheological properties. Contact stresses between bodies in compression. Mechanical damage. Aerodynamic and hydro-dynamic characteristics. Friction.
Department(s): School of Engineering
Location(s): Guelph

ENGG*6130 Special Topics in Engineering Unspecified [0.50]
The course objective is to train the student in preparing, delivering and evaluating technical presentations. Each student is required to: (a) attend and write critiques on a minimum of six technical seminars in the School of Engineering; and (b) conduct a seminar, presenting technical material to an audience consisting of faculty and graduate students in the school. This presentation will then be reviewed by the student and the instructor.
Department(s): School of Engineering
Location(s): Guelph

ENGG*6140 Special Topics in Engineering Unspecified [0.50]
A course of directed study involving selected readings and analyses in developing knowledge areas which are applicable to several of the engineering disciplines in the School of Engineering.
Department(s): School of Engineering
Location(s): Guelph
ENGG*6150 Bio-Instrumentation Unspecified [0.50]
Department(s): School of Engineering
Location(s): Guelph

ENGG*6160 Advanced Food Engineering Unspecified [0.50]
Application of heat and mass transfer, fluid flow, food properties, and food-processing constraints in the design and selection of food process equipment. Development of process specifications for the control of the flow of heat and moisture and the associated microbial, nutritional and organoleptic change in foods. Food system dynamics and process development.
Department(s): School of Engineering
Location(s): Guelph

ENGG*6170 Special Topics in Food Engineering Unspecified [0.50]
A course of directed study involving selected readings and analyses in developing knowledge areas of food engineering.
Department(s): School of Engineering
Location(s): Guelph

ENGG*6180 Final Project in Biological Engineering Unspecified [1.00]
A project course in which a problem of advanced design or analysis in the area of biological engineering is established, an investigation is performed and a final design or solution is presented.
Restriction(s): This course is open only to students in the biological MEng program.
Department(s): School of Engineering
Location(s): Guelph

ENGG*6190 Special Topics in Biological Engineering Unspecified [0.50]
A course of directed study involving selected readings and analyses in developing knowledge areas of biological engineering.
Department(s): School of Engineering
Location(s): Guelph

ENGG*6260 Colloids, Interfaces and Emulsions: Concepts and Practical Applications Winter Only [0.50]
This course focuses on the theory and the applications of colloid and interface science in the environmental, chemical, and food sectors. Major topics include the forces of interactions between colloids, the stabilization and destabilization of emulsions and foams, and polymeric fluids and gels.
Prerequisite(s): CHEM*1040 and CHEM*1050
Department(s): School of Engineering
Location(s): Guelph

ENGG*6270 Advanced Estimation Theory Winter Only [0.50]
This course provides a theoretical and practical understanding of advanced state and parameter estimation theory. Topics include, but are not limited to: linear and nonlinear models, system and measurement noise distributions, observers, optimal filters, robust strategies, and written communication skills. Students should have background knowledge in linear algebra, programming, and systems and control theory.
Prerequisite(s): ENGG*2400 or ENGG*3410
Department(s): School of Engineering
Location(s): Guelph

ENGG*6290 Special Topics in Mechanical Engineering Unspecified [0.50]
A course of directed study involving selected readings and analyses in developing knowledge areas of mechanical engineering.
Department(s): School of Engineering
Location(s): Guelph

ENGG*6300 Research Methods in Bioengineering Unspecified [0.50]
Research methodologies used in bioengineering are reviewed and assessed in the context of a diverse range of applications: biomechanics, control and instrumentation, ergonomics, diagnostic tools, biomaterials and food safety. The scientific method is discussed in terms of defining research problems, appropriate tests and hypotheses, experimental methods, data analysis and drawing conclusions. The objective is to guide students as they develop a coherent research proposal and deepen their understanding of the breadth of the discipline. (Offered in alternate years)
Restriction(s): Instructor consent required.
Department(s): School of Engineering
Location(s): Guelph

ENGG*6310 Advanced Electromechanical Devices Unspecified [0.50]
Course covers: switched reluctance motor, brushless motor, linear motor, axial flux motor, and harmonic drive motor with applicable actuators. Other topics introduced include: Electromagnetic micro power generation, design and analysis of cooling systems and control mechanism. Background in electromagnetism required. (Offered in alternate years)
Department(s): School of Engineering
Location(s): Guelph

ENGG*6320 Advanced Topics in Mechatronics Unspecified [0.50]
This course covers materials related to mechatronics systems in terms of dynamics, control, sensing, estimation. The course covers advanced topics in these areas and provides students the tools to model, analyze, and control these systems. The focus is on vehicles and robots (mobile robots).
Department(s): School of Engineering
Location(s): Guelph

ENGG*6330 Thermal Design of Heat Exchangers Winter Only [0.50]
This course provides students with practical experience in designing and modeling of heat exchangers for different applications. Students will apply theory and knowledge of heat and mass transfer, thermodynamics, and fluid mechanics to the design of heat exchanger devices for different applications. Students are expected to have already taken relevant undergraduate courses (ENGG*2230, ENGG*3260, ENGG*3370 and ENGG*3430, or equivalents).
Department(s): School of Engineering
Location(s): Guelph

ENGG*6340 Bioenergy and Biofuels Unspecified [0.50]
Theoretical and hands-on experience in bio-renewable energy areas prepares students from diverse backgrounds for a career in the biofuel industry, academia, or entrepreneurial endeavors. Also deals with the technologies of converting biomass into upgraded energy, value added products, fuels, and chemicals. Thermodynamics background helpful.
Department(s): School of Engineering
Location(s): Guelph
ENGG*6350 Flow Induced Vibrations Unspecified [0.50]
Course covers fluid-structure interaction problems with an emphasis on analytical and numerical methods. Topics include vortex and turbulence induced vibration, galloping and flutter, fluid-elastic instability, and acoustic resonance. Various case studies and applications will be discussed. Background in fluid mechanics and vibrations required. (Offered in alternate years)
Department(s): School of Engineering
Location(s): Guelph

ENGG*6360 Fuel Cell Technology Unspecified [0.50]
Examination of principles governing fuel cell technology and the technical challenges associated with developing fuel cell systems. Topics include the chemical thermodynamics and electrochemical kinetics of fuel cells, the evolution of fuel cell technology, and fuel cell system design. Background in materials and thermodynamics required.
Department(s): School of Engineering
Location(s): Guelph

ENGG*6370 Heat Transfer in Porous Medium Unspecified [0.50]
Course covers general conservation equations for studying the flow and heat transfer through porous media. Application and case studies of porous materials will be discussed. Modelling techniques will be shown for a particular application area. Background in Heat Transfer required. (Offered in alternate years)
Department(s): School of Engineering
Location(s): Guelph

ENGG*6380 Simulation Analysis of Discrete Event Systems Unspecified [0.50]
Many complex engineering, operations, and business systems can be modeled as discrete-event systems. Efficient management and operation of these systems requires simulation to study their performance. Case studies and applications will be presented and discussed. (Offered in alternate years)
Department(s): School of Engineering
Location(s): Guelph

ENGG*6390 Final Project in Mechanical Engineering Unspecified [1.00]
A project course in which a problem of advanced design or analysis in the area of mechanical engineering is established, an investigation is performed and a final design or solution is presented.
Restriction(s): Restricted to MENG.ENGG:L students.
Department(s): School of Engineering
Location(s): Guelph

ENGG*6400 Mobile Devices Application Development Unspecified [0.50]
This course provides an introduction to developing applications for mobile devices. The emphasis will be on the fundamentals of mobile application programming. This is primarily a project-based course in which the goal is to produce a working app by the end of the course. The purpose of this course is to create new inter-disciplinary applications of mobile devices. Graduate students from all disciplines at the University of Guelph are invited to take the course for credit.
Department(s): School of Engineering
Location(s): Guelph

ENGG*6440 Advanced Biomechanical Design Unspecified [0.50]
Biomechanical Design from concept through prototyping and testing. This course will investigate and apply techniques used for biomechanical design including reverse engineering, solid modelling, geometric tolerancing, testing and rapid prototyping. Instructor’s signature required.
Department(s): School of Engineering
Location(s): Guelph

ENGG*6450 Queueing Theory and Traffic Modeling Modeling
Data Unspecified [0.50]
Restriction(s): Instructor consent required.
Department(s): School of Engineering
Location(s): Guelph

ENGG*6460 Engineering Leadership Winter Only [0.50]
This course introduces engineering students to leadership concepts and theory in the context of application to the engineering profession and practice. The focus is on developing practical leadership knowledge, skills and attitudes, starting from the personal level and extending to application in the organizations and society. The content is presented and assessed through a blend of lectures, readings, case studies, discussions, presentations, workshops, reflective practice and a major project.
Department(s): School of Engineering
Location(s): Guelph

ENGG*6470 Solidification and Processing of Metals and Alloys Winter Only [0.50]
This course examines the fundamental principles of metal and alloy solidification. Aspects of nucleation, grain, growth, dendrite formation in casting and welding processes are examined. Thermal analysis, solidification defects and alloy characterization are also covered. Students are expected to have already taken undergraduate courses in materials science and manufacturing processes (ENGG*2120 and ENGG*2180, or equivalents).
Department(s): School of Engineering
Location(s): Guelph

ENGG*6480 Advanced Topics in Mechanical Systems Design Unspecified [0.50]
Introduces advanced design methodologies applicable to mechanical systems. Includes the following topics: materials selection; specialized design methods such as concurrent engineering, design for reliability and life cycle design; application of biologically inspired modeling, optimization methods and finite element analysis; integration of various tools to solve a specific engineering problem; implications of design decisions on sustainability and environment; and utilizing different software packages. Students are expected to have already taken undergraduate courses in materials science and machine design (ENGG*2120 and ENGG*3280, or equivalents).
Department(s): School of Engineering
Location(s): Guelph

ENGG*6490 Nonlinear and Intelligent Control With Winter Only [0.50]
The aim of this course is about nonlinear and intelligent control systems for mechatronics applications (mixture of theory and applications). Students will also learn about nonlinear systems and important concepts associated with them. Important control techniques both for linear and nonlinear systems will be taught (focus will be on nonlinear). Applications of various control techniques for vehicles and robotic systems will be taught as well. This course is suitable for students who have some background in control and mechatronics (ENGG*2500 and ENGG*3410, or equivalents).
Department(s): School of Engineering
Location(s): Guelph
ENGG*6500 Introduction to Machine Learning  
The aim of this course is to provide students with an introduction to algorithms and techniques of machine learning particularly in engineering applications. The emphasis will be on the fundamentals and not specific approach or software tool. Class discussions will cover and compare all current major approaches and their applicability to various engineering problems, while assignments and project will provide hands-on experience with some of the tools.  
Department(s): School of Engineering  
Location(s): Guelph

ENGG*6510 Analog Integrated Circuit Design  
In this course, operating principles and design techniques of analog integrated circuits are introduced with emphasis on device and system modelling. These circuits include analog and switched-capacitor filters, data converters, amplifiers, oscillators, modulators, circuits for communications, sensor readout channels, and circuits for integrated memories. It is recommended that students are familiar with the fundamentals of linear circuits, circuit analysis, and electronic devices.  
Department(s): School of Engineering  
Location(s): Guelph

ENGG*6520 VLSI Digital Systems Design  
This course will introduce the principles of VLSI MOSFET digital design from a circuit and system perspective. Advanced topics include: power issues related to each level of design abstraction; voltage and frequency scaling; power to speed tradeoffs; ASIC digital design flow; Verilog integration/intergration; ASIC case studies. It is recommended that students are familiar with the fundamentals of digital circuits and electronic devices.  
Department(s): School of Engineering  
Location(s): Guelph

ENGG*6530 Reconfigurable Computing Systems  
This course serves as a graduate introduction into reconfigurable computing systems. It introduces students to the analyses, synthesis and design of embedded systems and implementing them using Field Programmable Gate Arrays. Topics include: Programmable Logic devices, Hardware Description Languages, Computer Aided Design Flow, Hardware Accelerators, Hardware/Software Co-design techniques, Run Time Reconfiguration, High Level Synthesis. It is recommended that students are familiar with the fundamentals of digital design and hardware description languages.  
Department(s): School of Engineering  
Location(s): Guelph

ENGG*6540 Advanced Robotics  
This course is intended for graduate students who have some knowledge and interest in robotics. The course covers modelling, design, planning control, sensors and programming of robotic systems. In addition to lectures, students will work on a term project in which a problem related to robotics systems will be studied. Instructors signature required.  
Department(s): School of Engineering  
Location(s): Guelph

ENGG*6550 Intelligent Real-Time Systems  
Soft real-time systems, hard real-time systems, embedded systems, time handling and synchronization, deadlines, preemption, interruption, RTS languages, RTS/ operating systems, system life-cycle, petri nets, task scheduling and allocation, fault-tolerance, resource management, RTS/ search techniques, dealing with uncertainty.  
Department(s): School of Engineering  
Location(s): Guelph

ENGG*6560 Advanced Digital Signal Processing  
Discrete-time signals and systems, z transform, frequency analysis of signals and systems, fourier transform, fast fourier transform, design of digital filters, signal reconstruction, power spectrum estimation.  
Department(s): School of Engineering  
Location(s): Guelph

ENGG*6570 Advanced Soft Computing  
Neural dynamics and computation from a single neuron to a neural network architecture. Advanced neural networks and applications. Soft computing approaches to uncertainty representation, multi-agents and optimization.  
Prerequisite(s): ENGG*4430  
Department(s): School of Engineering  
Location(s): Guelph

ENGG*6580 Advanced Control Systems  
This course will start with state space analysis of multi-input multi-output control systems. Then state space design will be presented. After that, nonlinear control systems and soft computing based intelligent control systems will be studied. Finally, hybrid control systems, H infinite control and uncertainty and robustness in control systems will be addressed.  
Department(s): School of Engineering  
Location(s): Guelph

ENGG*6590 Final Project in Engineering Systems and Computing  
A project course in which a problem of advanced design or analysis in the area of Engineering Systems and Computing is established by the student, an investigation is performed, and a report on the final design or solution selected is presented.  
Restriction(s): Restricted to MENG.ENGG.L students.  
Department(s): School of Engineering  
Location(s): Guelph

ENGG*6600 Special Topics in Engineering Systems and Computing  
A course of directed study involving selected readings and analyses in developing knowledge areas of Engineering Systems and Computing.  
Department(s): School of Engineering  
Location(s): Guelph

ENGG*6610 Urban Stormwater Management  
Continuous stormwater management models and model structure. Catchment discretization and process disaggregation. Pollutant build-up, wash off and transport. Flow and pollutant routing in complex, looped, partially surcharged pipe/channel networks including pond storage, storage tanks, diversion structures, transverse and side weirs, pump stations, orifices, radial and leaf gates and transient receiving water conditions (including tides). Pollutant removal in sewer networks, storage facilities and treatment plants.  
Department(s): School of Engineering  
Location(s): Guelph

ENGG*6630 Environmental Contaminants: Fate Mechanisms  
Analysis of fate mechanisms associated with environmental contaminants. Focus on substances which are generally considered to be hazardous to humans, or other animal life at low concentrations. Study of physicochemical properties and fate estimation on control and remediation strategies. Quantitative analysis of contaminant partitioning and mass flows, including cross-media transport and simultaneous action of contaminant fate mechanisms.  
Department(s): School of Engineering  
Location(s): Guelph
ENGG*6650 Advanced Air Quality Modelling Unspecified [0.50]
Analysis of analytical and computational models used to predict the fate of airborne contaminants; role of air quality models for the solution of engineering-related problems; analysis of important boundary layer meteorology phenomena that influence the fate of air pollutants; conservation equations and mathematical solution techniques; model input requirements such as emissions inventories; Gaussian models; higher-order closure models; Eulerian photochemical grid models.
Department(s): School of Engineering
Location(s): Guelph

ENGG*6660 Renewable Energy Unspecified [0.50]
The engineering principles of renewable energy technologies including wind, solar, geothermal and biomass will be examined, including technology-specific design, economic and environmental constraints. Students will compare the relative merits of different energy technologies and gain a knowledge base for further study in the field.
Restriction(s): Restricted to MASC.ENGG, MENG and PHD.ENGG students.
Department(s): School of Engineering
Location(s): Guelph

ENGG*6670 Hazardous Waste Management Unspecified [0.50]
This course will define the different types of hazardous wastes that currently exist and outline the pertinent legislation governing these wastes. Information will be presented on different ways to handle, treat and dispose the hazardous waste, including separation, segregation, minimization, recycling and chemical, physical, biological, and thermal treatment. Also to be discussed are hazardous waste landfill sites and site remediation technologies. Specifics include design and operation of hazardous landfill sites, handling and treatment of leachate, comparison of pertinent soil remediation technologies. Case studies will be reviewed.
Department(s): School of Engineering
Location(s): Guelph

ENGG*6680 Advanced Water and Wastewater Treatment Unspecified [0.50]
This design course will discuss advanced technologies not traditionally covered during an undergraduate curriculum. An important consideration will be the reuse of water.
Department(s): School of Engineering
Location(s): Guelph

ENGG*6740 Ground Water Modelling Unspecified [0.50]
Introduction to current groundwater issues, definition of terms, review of fundamental equations describing fluid and contaminant transport in saturated groundwater zones. Mathematical techniques (analytical, FE and FD) for the solution of the fundamental equations. Application of numerical groundwater models to a variety of situations. Case studies. Review of groundwater models used in industry.
Department(s): School of Engineering
Location(s): Guelph

ENGG*6790 Special Topics in Environmental Engineering Unspecified [0.50]
A course of directed study involving selected readings and analyses in developing knowledge areas of environmental engineering.
Department(s): School of Engineering
Location(s): Guelph

ENGG*6800 Deterministic Hydrological Modelling Unspecified [0.50]
Department(s): School of Engineering
Location(s): Guelph

ENGG*6820 Measurement of Water Quantity and Quality Unspecified [0.50]
This course covers techniques used to measure rates of movement and amounts of water occurring as precipitation, soil water, ground water and streamflow. Available measurements of water quality are surveyed. Calculation procedures involved in the use of indirect indicators of water quantity and quality individually and in combination are described.
Department(s): School of Engineering
Location(s): Guelph

ENGG*6840 Open Channel Hydraulics Unspecified [0.50]
Basic concepts, energy principle; momentum principle; flow resistance; non-uniform flow; channel controls and transitions; unsteady flow; flood routing.
Department(s): School of Engineering
Location(s): Guelph

ENGG*6860 Stream and Wetland Restoration Design Unspecified [0.50]
Explores the multi-disciplinary principles of stream and wetland restoration and the tools and techniques for restoration design. Restoration design is approached from a water resources engineering perspective with emphasis on hydrological and hydraulic techniques. Numerous case studies are examined as a means to identify more successful design approaches.
Prerequisite(s): ENGG*3650
Department(s): School of Engineering
Location(s): Guelph

ENGG*6880 Soil Erosion and Fluvial Sedimentation Unspecified [0.50]
Students will be able to (i) describe processes related to soil erosion by water, (ii) describe processes related to fluvial sedimentation, (iii) evaluate and prescribe structural and non-structural control methods, and (iv) run at least one soil erosion/fluvial sedimentation computer model if the course is satisfactorily completed.
Department(s): School of Engineering
Location(s): Guelph

ENGG*6900 Final Project in Water Resources Engineering Unspecified [1.00]
A project course in which an advanced design problem in the area of watershed engineering is established, a feasibility investigation performed and a final design presented.
Restriction(s): Restricted to MENG:L students.
Department(s): School of Engineering
Location(s): Guelph

ENGG*6910 Special Topics in Water Resources Engineering Unspecified [0.50]
A course of directed study involving selected readings and analyses in developing knowledge areas of water resources engineering.
Department(s): School of Engineering
Location(s): Guelph
ENGG*6950  Final Project in Environmental Engineering  Unspecified  [1.00]
A project course in which a problem of advanced design or analysis in the area of environmental engineering is established, an investigation is performed and a final design or solution is presented.
Restriction(s): Restricted to MENG:L students.
Department(s): School of Engineering
Location(s): Guelph

ENGG*6980  Special Topics in Computer Engineering  Unspecified  [0.50]
This course addresses specialized topics in one or more aspects of Computer Engineering not covered by other graduate courses. Includes selected readings and thorough analyses in emerging knowledge areas, advanced engineering tools, and current technical developments. May be repeated for credit as topics vary.
Department(s): School of Engineering
Location(s): Guelph

ENGG*6990  Final Project in Computer Engineering  Unspecified  [1.00]
An independent project carried out under the supervision of a Computer Engineering faculty member in which an advanced modelling or design problem and the desired outcomes are defined, possible solutions are synthetized and analyzed, and a final model or design is evaluated. Regular meetings, final report, and presentation required.
Restriction(s): Restricted to MENG:L students.
Department(s): School of Engineering
Location(s): Guelph