2006-2007 Graduate Calendar

The information published in this Graduate Calendar outlines the rules, regulations, curricula, programs and fees for the 2006-2007 academic years, including the Summer Semester 2006, the Fall Semester 2006, the Winter Semester 2007 and the Summer 2007.

For your convenience the Graduate Calendar is available in PDF format.

If you wish to link to the Graduate Calendar please refer to the Linking Guidelines.

The University is a full member of:

- The Association of Universities and Colleges of Canada

Contact Information:

University of Guelph
Guelph, Ontario, Canada
N1G 2W1

519-824-4120
http://www.uoguelph.ca

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Disclaimer

The Office of Graduate Program Services has attempted to ensure the accuracy of this on-line Graduate Calendar. However, the publication of information in this document does not bind the university to the provision of courses, programs, schedules of studies, fees, or facilities as listed herein.

Limitations

The University of Guelph reserves the right to change without notice any information contained in this calendar, including any rule or regulation pertaining to the standards for admission to, the requirements for the continuation of study in, and the requirements for the granting of degrees or diplomas in any or all of its programs.

The university will not be liable for any interruption in, or cancellation of, any academic activities as set forth in this calendar and related information where such interruption is caused by fire, strike, lock-out, inability to procure materials or trades, restrictive laws or governmental regulations, actions taken by the faculty, staff or students of the university or by others, civil unrest or disobedience, or any other cause of any kind beyond the reasonable control of the university.

The University of Guelph reaffirms section 1 of the Ontario Human Rights Code, 1981, which prohibits discrimination on the grounds of race, ancestry, place of origin, colour, ethnic origin, citizenship, creed, sex, sexual orientation, handicap, age, marital status or family status.

The university encourages applications from women, aboriginal peoples, visible minorities, persons with disabilities, and members of other under-represented groups.

Table of Contents

Engineering

The graduate degree programs in engineering include research and course work options, as well as full- and part-time studies. A thesis-based MSc degree program is available in four research fields: biological engineering, environmental engineering, engineering systems and computing, and water resources engineering. An MEng degree is offered in three areas: water resources engineering, environmental engineering and biological engineering.

The research-based MSc and PhD programs provide the opportunity to obtain advanced training in the engineering sciences and in research methodology through a variety of applied and basic research topics and courses. They provide for specialization in the fields of biological engineering, environmental engineering, engineering systems and computing, and water resources engineering. Biological engineering research concentrates biological processing environments and human factors; it covers physical processing of food, restructuring of foods and wastes, physical properties of biological materials, and biomechanics. Environmental engineering research examines methods to understand and enhance processes central to environmental protection. It includes the assessment of the fates of substances in the environment, development of new process technology and remediation of contaminated material and sites. Water resources engineering research concentrates on watershed engineering, hydrology, erosion, drainage & irrigation flood control, water-resource systems management, soil and water conservation, storm water and water-quality management. Engineering Systems & Computing research examines techniques, methods and procedures for systems where the computer plays an integral role. In today's society, a computer is intimately integrated into industrial processes and everyday appliances and equipment. Research encompasses aspects of software, hardware, intelligence as well as a focus on particular application areas. Software areas include real-time systems, embedded computing, distributed processing as well as communication systems. Hardware areas include VLSI, special purpose computing and embedded systems. Intelligent systems exploration into control, autonomous robotics, machine vision, image processing, soft computing and human-machine interfaces. Typically a research project will be within the scope of an application area, for example automation, biomedical, food sciences or environmental.

The objective of the MEng degree in biological engineering, water resources engineering and environmental engineering is to provide students (mostly practising engineers) the opportunity to extend their understanding of engineering principles involved in these disciplines beyond the coverage possible in an undergraduate program and to enlarge their grasp of the application of these principles to the solution of complex, practical problems. Areas of emphasis currently covered in water resources engineering are hydrologic modelling and model applications of water supply assessment, pollutant transport and management, watershed management, agricultural water management including irrigation, drainage, erosion and sediment transport and design of naturalized channels. The areas of emphasis currently covered in environmental engineering are water treatment, site remediation, management of agriculture and municipal solid and liquid wastes and risk assessment. Areas of emphasis currently covered in biological engineering are food engineering, and bioprocess engineering.

Administrative Staff

Director
John Gruzleski (2385 Thornbrough, Ext. 52430)
jgruzles@uoguelph.ca

Acting Associate Director
Douglas Joy (2342 Thornbrough, Ext. 53048)
djoy@uoguelph.ca

Graduate Co-ordinator
Ralph Brown (2340 Thornbrough, Ext. 53922/56187)
rbbrown@uoguelph.ca

Graduate Secretary
Lucy Cremasco (2363 Thornbrough, Ext. 56187)
soegrad@uoguelph.ca

Graduate Faculty

Hussein A. Abdullah
BSc University of Technology, MSc, Ph.D. Glasgow - Associate Professor

Shawki Areibi
BASc Al-Fateh, MASc Waterloo, Ph.D. Waterloo - Associate Professor

Andrea L. Bradford
BSc, PhD Queen's - Assistant Professor

Ralph B. Brown
BSc (Agr), BSc (Eng), MSc, PhD Guelph, PEng - Professor

Valerie J. Davidson
BEng McMaster, MSc Guelph, PhD Toronto, PEng - Professor

Robert Dony
BASc, MASc Waterloo, PhD McMaster, PEng - Assistant Professor

Khosrow Farahbakhsh
PhD Alberta, PEng - Assistant Professor

Dalia Fayek
PhD Waterloo, PEng - Assistant Professor

Bahram Gharabaghi
BSc Iran Univ. of Science and Technology, MSc Sharrif Univ. of Science and Technology, PhD Guelph - Assistant Professor

Karen D. Gordon
BSc Guelph, PhD Waterloo - Assistant Professor

Stefano Gregori
MSc, PhD Pavia (Italy) - Assistant Professor

Gordon L. Hayward
BASc, MASc, PhD Waterloo, PEng - Associate Professor

Isobel W. Heathcote
BSc Toronto, MS Yale, PhD Yale - Dean of Graduate Studies, Director of the Institute for Environmental Policy and Professor (Joint appointment with the Faculty of Environmental Sciences)

Douglas M. Joy
BASc Toronto, MASc Ottawa, PhD Waterloo, PEng - Associate Professor and Acting Associate Director

Edward McBean
PhD Massachusetts Institute of Technology, PEng - Professor

Gauri S. Mittal
BSc Punjab Agricultural, MSc Manitoba, PhD Ohio State, PEng - Professor

Medhat A. Moussa
BSc American, MASc Moncton, PhD Waterloo - Assistant Professor

Radu Muresan
Dipl. Engg Technical Univ. of Cluj-Napoca (Romania); MASc, PhD Waterloo - Assistant Professor

Michele L. Oliver
BPE McMaster, MPE, MSc, PhD New Brunswick - Assistant Professor

Lambert Otten
BASc, MASc, PhD Waterloo, PEng - Professor

Ramesh P. Rudra
BSc Punjab Agricultural, MS, PhD Pennsylvania State, PEng - Professor

R. John Runciman
BSc Queen's, MSc Queen's, PhD (Strathclyde), PEng - Associate Professor

Warren Stiver
BASc, MASc, PhD Toronto, PEng - Professor

Bill Van Heyst
BASc, MASc, PhD Waterloo - Assistant Professor

Simon X. Yang
BSc Peking, MSc Sinica, MSc Houston, PhD Alberta - Associate Professor

Hongde Zhou
BSc Jiangsu, MSc China, PhD Alberta, PEng - Associate Professor

Richard G. Zytner
BASc, MASc, PhD Windsor, PEng - Professor and Acting Director

MSc Program

Admission Requirements

MSc by Thesis

In addition to the general admission standards of the university, the school has adopted additional admissions criteria for MSc studies. Applicants must meet one of the following requirements:

- Bachelor's degree in engineering or equivalent. At least a second class honours standing in the work of the last four full-time semesters or the last two complete undergraduate years.
- Science degree or equivalent. Applicant must be a graduate from an honours Engineering program with at least a 75% average in the past four full-time semesters or the equivalent. International degree and grade equivalents will be determined by Graduate Program Services. Applicant must have demonstrated an acceptable analytical ability by having taken a sufficient number of courses in mathematics, chemistry and physics. Applicant must be prepared to make-up undergraduate engineering courses without receiving graduate credit in topics related to the research project.

MEng Program

Applicant must be a graduate from an honours program with at least a 70% average in the past four full semesters or the last two complete undergraduate years or the equivalent. International degree and grade equivalents will be determined by Graduate Program Services.

Applicant must have demonstrated an acceptable analytical ability by having taken a sufficient number of courses in mathematics, and the physical sciences.

For the environmental engineering degree the applicant must have a minimum of three of the following courses or equivalent:

- Introduction to Environmental Engineering
- Engineering Unit Operations

- Water Quality
- Air Quality
- Solid Waste Management
- Water and Wastewater Treatment
- Ecology.

For water resources engineering the applicant must have four of the following courses or equivalent:

- Fluid Mechanics
- Water Management
- Hydrology
- Water Quality
- Urban Water Systems
- Watershed Structures
- Soil and Water Conservation

For biological engineering the applicant must have a minimum requirement of three of the following courses or equivalent.

- Biological/Food/Bioprocess Engineering
- Engineering Unit Operations
- Bioreactor Design
- Bio instrumentation Design
- Food Process Engineering Design
- Digital Process Control Design
- Heat and Mass Transfer
- Process Engineering.

Applicant qualifications may be assessed via an entrance interview/oral examination conducted by the graduate co-ordinator and one member of the school of engineering graduate studies committee. Students deficient in certain areas will be required to take make-up undergraduate courses. The student will be admitted on probation until the requirements have been completed. These courses will not count toward the student's graduate credit requirements.

Degree Requirements

MSc by Thesis

The prescribed program of study must consist of no fewer than 2.0 credits, of which at least 1.5 credits must be at the graduate level, including the Engineering Seminar course and at least two other engineering courses. Under special circumstances the school may reduce the 1.5 credit course requirement; however, the two graduate-engineering-course requirement will not be changed. In all cases the remaining courses must be acceptable for graduate credit; that is, they must be either graduate courses or senior undergraduate courses. Depending on the student's background, the advisory committee may specify more than four courses, including undergraduate make-up courses. If make-up courses are deemed necessary, they will be considered additional courses.

MEng Degree

The prescribed studies program consists of at least 5.0 credits acceptable for graduate credit. This includes 2.5 credits from the program core (see section 5.4 of the School of Engineering Graduate Handbook), and 2.5 additional credits chosen from approved courses (section 5.5 of the School of Engineering Graduate Handbook). No more than 1.0 of these credits will be for undergraduate engineering courses, as approved by the graduate co-ordinator, and no more than 1.5 credits will be from courses offered outside the School of Engineering. For the final project the student will make arrangements with one of the graduate faculty to act as advisor.

PhD Program

Admission Requirements

The minimum academic requirement for admission to the PhD program is normally a recognized master's degree in engineering. A strong recommendation from the MSc advisor is necessary. Direct admission to the PhD program is rarely granted. Applicants requesting direct admission must hold a bachelor's degree with exceptionally high academic standing and have related research experience. Such applicants should discuss this option with the graduate co-ordinator at an early opportunity.

Degree Requirements

The prescribed program of study must consist of no fewer than 2.0 credits in addition to those taken as part of the MSc degree. At least 1.5 of the credits must be at the graduate level, including the Engineering Seminar course and at least two graduate engineering courses. Under special circumstances the school may reduce the requirement for 1.5 credits in graduate courses; however the two graduate-engineering-course requirement will not be changed. In all cases the remaining courses must be acceptable for graduate credit; that is, they must be either graduate courses or senior undergraduate courses. Depending on the student's background, the advisory committee may specify more than four courses, including undergraduate make-up courses. If make-up courses are deemed necessary, they will be considered additional courses.

Students who have completed their MSc degree in the School of Engineering are not required to enrol in the graduate Engineering Seminar course, and their credit requirements are reduced. The qualifying examination as outlined in the Graduate Calendar is held by the end of the fourth semester but no later than the fifth semester after the student has completed the required courses.

Interdepartmental Programs

MSc Aquaculture Interdepartmental Program

The School of Engineering participates in the master of science in aquaculture program. Those faculty members whose research and teaching expertise includes aspects of aquaculture may serve as advisers for MSc (Aquaculture) students. Please consult the Aquaculture listing for a detailed description of the MSc (Aquaculture) interdepartmental program.

MSc Food Safety and Quality Assurance Collaborative Program

The School of Engineering participates in the MSc program in food safety and quality assurance. Those faculty members whose research and teaching expertise includes aspects of food safety and quality assurance may serve as advisers for MSc students. Please consult the Food Safety and Quality Assurance listing for a detailed description of the MSc collaborative program.

Courses

General

ENGG*6000 Advanced Heat and Mass Transfer F [0.50]

Basic physical principles of transport phenomena. Heat and mass transfer methods for physical systems. Time and volume averaging. Dimensional analysis.

ENGG*6020 Advanced Fluid Mechanics U [0.50]

Laminar and turbulent flow. Turbulence and turbulence modelling. Boundary-layer flow. Compressible flow. Potential flow.

ENGG*6030 Finite Difference Methods W [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.

ENGG*6050 Finite Element Methods W [0.50]

Boundary-value problems. Methods of approximation. Time dependent problems. Isoparametric elements. Numerical integration. Computer implementation. Mesh generation and layouts. Two-dimensional finite elements.

ENGG*6060 Engineering Systems Modelling and Simulation U [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.

ENGG*6080 Engineering Seminar W [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.

ENGG*6090 Special Topics in Engineering W [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.

Biological Engineering

ENGG*6110 Food and Bio-Process Engineering W [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.

ENGG*6120 Fermentation Engineering F [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.

ENGG*6130 Physical Properties of Biomaterials F [0.50]

Rheology and rheological properties. Contact stresses between bodies in compression. Mechanical damage. Aerodynamic and hydro-dynamic characteristics. Friction.

ENGG*6150 Bio-Instrumentation W [0.50]

Instrumentation systems. Transducers. Amplifier circuits. Recording methods. Spectroscopy & colorimetry. Radiation, humidity, pH and noise measurements. Chromatography.

ENGG*6160 Advanced Food Engineering F [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.

ENGG*6170 Special Topics in Food Engineering U [0.50]

A course of directed study involving selected readings and analyses in developing knowledge areas of food engineering.

ENGG*6180 Final Project in Biological Engineering U [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.

ENGG*6190 Special Topics in Biological Engineering W [0.50]

A course of directed study involving selected readings and analyses in developing knowledge areas of biological engineering.

ENGG*6290 Special Topics in Agricultural Engineering U [0.50]

A course of directed study involving selected readings and analyses in developing knowledge areas of agricultural engineering.

ENGG*6440 Advanced Biomechanical Design F [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.

Environmental Engineering

ENGG*6610 Urban Stormwater Management W [0.50]

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, radical and leaf gates and transient receiving water conditions (including tides). Pollutant removal in sewer networks, storage facilities and treatment plants.

ENGG*6620 Water Pollution Control Planning F [0.50]

Methods of developing area-wide pollution control plans and sustainable use plans in Ontario and elsewhere. Quantitative and non-quantitative information is examined in the context of planning, using continuous models such as HSP-F. Field trips.

ENGG*6630 Environmental Contaminants: Fate Mechanisms W [0.50]

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.

ENGG*6640 Environmental Contaminants: Control Mechanisms W [0.50]

Analysis of conventional and innovative technologies for toxic contaminants; technologies for contaminated municipal and industrial waste waters, including physical, chemical, and biological treatment processes for trace toxic contaminants in water and wastewater; control technologies for contaminated gas streams, including activated carbon absorption, biofiltration, bioscrubbing, wet scrubbing, thermal- oxidation methods, and process modifications to reduce emissions of toxic air contaminants; remediation techniques for contaminated soil, including external and in-situ physical, chemical and biological treatment methods; cross-media contaminant control issues; toxicity testing and evaluation; relevant regulatory programs.

ENGG*6650 Advanced Air Quality Modelling W [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.

ENGG*6670 Hazardous Waste Management F [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 landfills 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.

ENGG*6680 Advanced Water and Wastewater Treatment F [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.

ENGG*6690 Non-Point Source Pollution and Its Control F [0.50]

Introduction to issues of non-point source pollution. Modelling of non-point source pollution approaches for vadose zone, surface and subsurface drained water. Scale issues in non- point source modelling. Management issues in non-point source pollution modelling. Application of non-point source pollution models to a variety of situations. Application of non- point source modelling and selection of management approaches for various types of receiving water.

ENGG*6790 Special Topics in Environmental Engineering U [0.50]

A course of directed study involving selected readings and analyses in developing knowledge areas of environmental engineering.

ENGG*6950 Final Project in Environmental Engineering U [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.

Engineering Systems and Computing

ENGG*6070 Medical Imaging W [0.50]

Digital image processing techniques including filtering and restoration; physics of image formation for such modalities as radiography, MRI, ultrasound.

Prerequisite(s): ENGG*3390 or equivalent

ENGG*6100 Machine Vision F [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.

ENGG*6140 Optimization Techniques for Engineering W [0.50]

This course serves as a graduate introduction into combinatorics and optimization. Oprimization 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.

ENGG*6440 Advanced Biomechanical Design F [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.

ENGG*6530 Reconfigurable Computing W [0.50]

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.

Prerequisite(s): ENGG*2410 or equivalent.

ENGG*6540 Advanced Robotics W [0.50]

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.

ENGG*6550 Intelligent Real-time Systems W [0.50]

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.

ENGG*6560 Advanced Digital Signal Processing W [0.50]

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.

ENGG*6570 Advanced Soft Computing F [0.50]

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 optimizastion.

Prerequisite(s): ENGG*4430 or equivalent

ENGG*6580 Advanced Control Systems F [0.50]

This course will start with state space analysis of multi-input multi-output control systems. Then state space design will be presented. After that, non linear 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. .

Water Resources Engineering

ENGG*6740 Ground Water Modelling W [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.

ENGG*6800 Deterministic Hydrological Modelling W [0.50]

Deterministic hydrological models. Function of watershed models for hydraulic design, environmental assessment, operation of water control structures, flood warning. Calculation algorithms.

ENGG*6810 Stochastic Hydrological Modelling U [0.50]

Distribution function selection for historic hydrologic data representation. Monte Carlo simulation techniques. ARMA modelling of hydrologic processes. Regional analysis. Risk analysis.

ENGG*6820 Measurement of Water Quantity and Quality U [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.

ENGG*6830 Design of Pressurized Flow Systems U [0.50]

Boundary resistance. Steady State and transient flow in gravity and pumped systems. Pressure control systems.

ENGG*6840 Open Channel Hydraulics W [0.50]

Basic concepts, energy principle; momentum principle; flow resistance; non-uniform flow; channel controls and transitions; unsteady flow; flood routing.

ENGG*6850 Design of Water Management Systems U [0.50]

Analytical decision making. Optimization methods. Planning under uncertainty. Deterministic river basin modelling. Irrigation planning and operation. Water quality management modelling.

ENGG*6880 Soil Erosion and Fluvial Sedimentation U [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.

ENGG*6900 Final Project in Water Resources Engineering U [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.

ENGG*6910 Special Topics in Water Resources Engineering U [0.50]

A course of directed study involving selected readings and analyses in developing knowledge areas of water resources engineering.