

CIVIL ENGINEERING

CURRICULUM

Master of Applied Science

DEGREE REQUIREMENTS

| | Credits |
|--|-------------|
| Master's Thesis | (Milestone) |
| CV8010 Master's Research Seminar | Pass/Fail |
| Five Elective credits (One may be a Directed Studies course) | 5 |

Master of Engineering

DEGREE REQUIREMENTS

| | Credits |
|---|-------------|
| Master's Project* | (Milestone) |
| Eight Elective credits (One may be a Directed Studies course) | 8 |

*students may apply to substitute 2 courses for the project.

Doctor of Philosophy

DEGREE REQUIREMENTS

| | Credits |
|--|-------------|
| Candidacy Examination | (Milestone) |
| Dissertation | (Milestone) |
| CV8020 PhD Research Seminar | Pass/Fail |
| Four Elective credits (One may be a Directed Studies course) | 4 |

ELECTIVES

| | Credits |
|--|---------|
| CV8100 Directed Studies: Engr | 1 |
| CV8102 Construction Project Mgmt | 1 |
| CV8105 Construction Admin and Mgmt | 1 |
| CV8106 Advances in Concrete Materials | 1 |
| CV8200 Proc for Wtr Pollution Control | 1 |
| CV8201 Surface Wtr Quality Modelling | 1 |
| CV8202 Surface Wtr Pollution Analyses | 1 |
| CV8204 Soil Remediation | 1 |
| CV8205 Spec Topics: Env Engineering | 1 |
| CV8206 Water Resource System Analysis | 1 |
| CV8207 Waste Management | 1 |
| CV8300 Solid Mechanics | 1 |
| CV8301 Appl of Finite Element | 1 |
| CV8302 Dynamics of Structures | 1 |
| CV8303 Renov/Repair - Existing Struct | 1 |
| CV8304 High Perf Concrete Structures | 1 |
| CV8306 Durability of Structures | 1 |
| CV8307 Adv. Reinforced Concrete Design | 1 |
| CV8308 Bridge Design and Construction | 1 |
| CV8309 Spec Topics: Structural Engr | 1 |
| CV8310 Adv Foundation Design | 1 |
| CV8311 Risk and Reliability for Eng | 1 |
| CV8312 Steel-Skinned Comp Struct Sys | 1 |
| CV8313 Prestressed Concrete | 1 |
| CV8314 Anal Des & Cons of Tall Buildg | 1 |
| CV8400 Road Safety | 1 |

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|--------|--------------------------------|---|
| CV8401 | Traffic Operations and Mgmt | 1 |
| CV8403 | Transportation Planning | 1 |
| CV8405 | Pavement Design and Mgmt | 1 |
| CV8406 | Adv Highway Geometric Design | 1 |
| CV8407 | Special Topics: Transportation | 1 |
| CV8500 | Advanced Satellite Positioning | 1 |
| CV8501 | Adv Top in Spatial Info Sys | 1 |
| CV8503 | Geospatial Model and Visualiz | 1 |
| CV8504 | Adv Estim and Data Series Anal | 1 |
| CV8505 | Design/Impl of Spat Info Sys | 1 |
| CV8506 | Industrial Metrology | 1 |
| CV8507 | Satellite Remote Sens: Urban | 1 |
| CV8508 | Special Topics: Geomatics | 1 |

COURSE LISTING

Master's Thesis

The student is required to conduct advanced research on a topic chosen in consultation with the student's thesis supervisor. The supervisory committee and the thesis supervisor must approve the thesis research plan/proposal, which is presented in writing by the student. The student must submit the completed research in a thesis format to an examination committee and make an oral presentation of the research thesis, and the research results, to this committee. The examination committee will assess and grade the thesis. Through the thesis, the student is expected to furnish evidence of competence in research and a sound understanding of the specialty area associated with the research. This is a "Milestone." Pass/Fail

Master's Project

The Project may consist of an advanced design assignment, laboratory research project, analysis of research data, or an in-depth review of an approved aspect of the scientific literature. The student submits a written proposal of the project plan, which must be approved by the project supervisor, and the supervisory committee. The MEng candidate must submit two copies of the completed project report to the supervisor. An oral presentation of the project report, and results, will be arranged in a seminar format. The supervisor and another member of the supervisory committee will assess and grade the report. This is a "Milestone." Pass/Fail

PhD Candidacy Examination

This is a "Milestone." Pass/Fail

PhD Dissertation

Pre-requisite: Candidacy Examination. This is a "Milestone." Pass/Fail

CV8010 Master's Research Seminar

This course consists of weekly seminars emphasizing current research in specialized areas of Civil Engineering, including Environmental, Geomatics, Structural, and Transportation. This course will run through Fall and Winter semesters. Presentations will be given by MASC students, faculty members, visiting scholars and guest speakers. In order to achieve a pass grade in the course, the student must attend a minimum of 75% of the seminars in his/her first year of study. Following year one, the student will register in a research presentation milestone and present an oral presentation on his/her research work. Pass/Fail.

CV8020 PhD Research Seminar

This course consists of weekly seminars emphasizing current research in specialized areas of Civil Engineering, including Environmental, Geomatics, Structural, and Transportation. This course will run through Fall and Winter semesters. Presentations will be given by Ph.D. students, faculty members, visiting scholars and guest speakers. In order to achieve a pass grade in the course, the student must attend a minimum of 75% of the seminars in his/her first year of study. Following year one, the student will register in two research presentation milestones and present two oral presentations on his/her research work. Pass/Fail.

CV8100 Directed Studies in Engineering

Various possibilities exist for pursuing directed studies on topics approved by the course supervisor and thesis supervisor, including the other specialization course topics where they are not offered on a formal basis. 1 Credit

CV8102 Construction Project Management

The objective of this course is to provide participants with a detailed framework for understanding how engineering and construction projects are successfully planned, organized and controlled, and to equip them with some of the tools and techniques for developing and improving their managerial skills. Participants will learn how the various parties in the construction process organize projects, and in particular how to maximize the possibilities of realizing projects of the correct quality on time and within budget. The depth and practicality of the course will benefit participants who ideally will have at least a couple of years of industrial experience.

1 Credit

CV8105 Construction Administration and Management

This course offers topics that focus on skills and techniques useful in administering and managing within a project environment of the construction industry. Participants should, preferably, have some previous responsibilities in one or more phases of the development of major constructed facilities, either in the planning, design, or construction of the facilities. Topics offered include international and Canadian construction, organizational design for projects and companies, management control structures and processes, meetings and negotiations, managing change in organizations, power struggles and politics in organizations, conflicts and their resolutions, claims and disputes in the industry, and the all important issue of construction safety. 1 Credit

CV8106 Advances in Concrete Materials

Chemistry and manufacturing of Portland cement; Supplementary cementing materials; Chemical admixtures for concrete; Properties of hardened concrete; Chemistry and mechanics of concrete deterioration and effects of SCM; Concrete of special properties; Advance experimental techniques in concrete. 1 Credit

CV8200 Processes for Water Pollution Control

This course expands on the principles and designs involved in the handling and treatment of different water pollution control systems: municipal, stormwater, and combined sewer overflows. Topics cover physical, chemical, and biological treatment processes, as well as the more advanced and innovative treatment including carbon columns for dissolved organics removal, biochemical phosphorus removal, biological nitrification-denitrification, ammonia stripping, alternative disinfection methods, and detoxification of sludge. A theoretical approach, supplemented by practical design applications and problem solving, will be adopted. Antirequisite ES8902. 1 Credit

CV8201 Surface Water Quality Modelling

This course provides the fundamental concepts for modeling the physio-chemical and biological processes that pollutants undergo when discharged into different types of water bodies. Major topics include mass-balance and hydrodynamic equations in rivers, estuaries, harbours and lakes; finite-difference and finite element solution approaches; steady-state and time-variable pollutant discharges, principal water quality problems; dissolved oxygen eutrophication, toxic substances, indicator bacteria and viruses. Bioaccumulation of chemicals in aquatic animals and fishes through the food-chain and water vectors. Antirequisite ES8906. 1 Credit

CV8202 Surface Water Pollution Analyses

A quantitative analysis of surface water pollution pathways is crucial to the development of water pollution prevention and control plans. This course will discuss the point and non-point sources in urbanized areas with emphasis on modeling approaches and analysis techniques. Topics include: surface hydrology, municipal water use cycle, urban drainage systems, point and non-point pollution control strategies for sanitary, storm, and combined sewer systems. 1 Credit

CV8204 Soil Remediation

This course overviews the design and operation of processes for soil remediation. Contaminants of interest include halogenated and non-halogenated volatiles, halogenated and non-halogenated semi-volatiles, flue hydrocarbons, pesticides and inorganics. Seven groups of technologies will be examined: (1) excavation and off-site disposal, (2) soil venting, (3) bioremediation, (4) thermal technologies, (5) chemical technologies, (6) mechanical flushing and washing, and (7) natural attenuation. Antirequisite ES8908. 1 Credit

CV8205 Special Topics in Environmental Eng.

The subject matter changes from year to year. The course description will be announced prior to the scheduling of the course. 1 Credit

CV8206 Water Resources System Analysis

This course deals with the planning, design and management of multi-component water resources systems. After a review of the use and nature of water resources systems, topics studied in detail are: water resource economics, methodology of design, system analysis, system design and decision making, applied mathematical programming, probabilistic models and water quality sub-systems. Antirequisite: CVL903. 1 Credit

CV8207 Waste Management

This course describes the development of solid waste management in response to legislative requirements for waste transport and disposal. To know when solid waste is a resource or a disposal problem requires its analysis and classification. Processing and handling of solid waste demands the proper application of available technology and basic engineering principles. These will be explained and followed by more advanced principles related to separation (including recycling), processing, and transformation of solid waste. Hazardous waste and hazardous materials, as well as federal and provincial regulatory processes governing hazardous wastes, will also be examined. Waste stabilization and solidification, land disposal of waste, environmental site and subsurface characterization will be discussed. Physical conversion of waste including incineration technologies, chemical and biological conversion technologies as well as successful combinations of the three will be described. The course will conclude with a brief review of the main issues in integrated solid waste management. Antirequisite ES8904. 1 Credit

CV8300 Solid Mechanics

Stress: notation; 2D and 3D transformation; differential equations of equilibrium; principal stresses; invariants. Strain: strain displacement equations; 2D transformation; relative displacement and notations. Isotropic stress strain formulations for plane stress, plain strain and 3D. Polar coordinates: governing equations and solutions. Tensor fundamentals; index notation; vector

transformation of components; Kronecker; permutation symbols; tensor algebra; Gauss theorem. Equations of elasticity in tensor notation. Energy theorems. 1 Credit

CV8301 Appl.of Finite Element Meth.in Struct.Eng.

Application of stiffness method for trusses and frames. Direct formulation of CST and thermal-seepage. Finite element formulation by virtual work. Elements: triangular, Lagrangian and serendipity rectangles; numerical integration; curvilinear elements; three-dimensional elements; plates, shells and axisymmetric elements. Convergence: Rayleigh-Ritz method; patch test; reduced integration. Solution of special problems: 2D and 3D problems; secondary effects; non-linear problems; soil-structure interaction. 1 Credit

CV8302 Dynamics of Structures

Free-vibration. Damping in structures. Response to harmonic and periodic excitations. Response to arbitrary, step and pulse excitations. Numerical evaluation of dynamic response. Earthquake response of linear systems. Earthquake response to inelastic systems. Structural dynamics in International Building Codes. 1 Credit

CV8303 Renovation/Repair of Existing Structures

Maintenance, renovation, rehabilitation and preservation of infrastructure. Mechanisms of mechanical, chemical and biological infrastructure degradation. Corrosion of steel condition surveys and evaluation of buildings and bridges repair and preservation of materials, techniques and strategies. Codes and guidelines. Case Studies. 1 Credit

CV8304 High Performance Concrete Structures

This course deals with the use of high performance concrete (HPC) in structures. Topics include: HPC principles, relevant properties of HPC, materials and mechanical properties, producing and curing HPC, shrinkage problems, temperature effects, design issues, case studies. 1 Credit

CV8306 Durability of Structures

Basic concepts, durability, safety, repair and strengthening. Deterioration mechanisms, corrective and preventive measures. Reliability analysis. Design for durability. Bridges. Parking structures. Steel, timber and masonry structures. Management systems. Strengthening and retrofitting. Case studies. 1 Credit

CV8307 Adv. Reinforced Concrete Design

Reinforced Concrete: Mechanics of reinforced concrete; truss model and compression field theory for beams failing in shear; design of two-way slabs; design of slender columns; shear friction and horizontal shear transfer; design for combined shear and torsion; design of deep beams and corbels. . Antirequisite: CVL 904. 1 Credit

CV8308 Bridge Design and Construction

Types of bridges; material properties and design of timber, steel and concrete elements; bridge loads; load distribution in bridge superstructures; simplified methods of analysis, with reference to the Canadian Highway Bridge Design Code; design of slab bridges; design of slab-beam bridges; design of box-girder bridges; joints, bearings, bridge piers and abutments. Antirequisite: CVL905. 1 Credit

CV8309 Special Topics in Structural Engineering

The subject matter changes from year to year. The course description will be announced prior to the scheduling of the course. 1 Credit

CV8310 Advanced Foundation Design

This course considers practical design of advanced shallow and deep foundations for various structures. The topics cover review of soil mechanics, subsurface investigation, foundation type, design principles, shallow foundation, pile design for axial and lateral loads, pile group design, shaft design, micropile design, and numerical simulation of foundations using software. 1 Credit

CV8311 Risk and Reliability for Eng

The main purpose of this course is to present a comprehensive introduction to risk and reliability theory as it relates to modern engineering services. Starting with a review of probability and statistics, the course will cover structural reliability methods, reliability-based structural design, statistical methods for reliability and deterioration data analysis, stochastic modeling for inspection and maintenance, and project risk management. 1 Credit

CV8312 Steel-Skinned Comp Struct Sys

The aim of this course is to equip students with advanced knowledge of multi-disciplinary aspects of modeling, analysis, design and construction of steel-skinned composite structural systems. 1 Credit

CV8313 Prestressed Concrete

The primary objective of this course is to explain the basic concepts necessary to understand and predict the response of prestressed concrete members and to design prestressed concrete structures. Basic concept of prestressing including pretensioning and post-tensioning technology will be reviewed. A comprehensive summary of the material properties of concrete and prestressing steel is given. The course provides a basic understanding of prestressed concrete behaviour including design procedure for members subjected to flexure and shear and estimating relevant deflection of prestressed concrete beams. 1 Credit

CV8314 Anal Des and Cons of Tall Buildg

Overview of design philosophy and structural forms/systems for tall buildings; loadings and Code based analyses; lateral load resisting systems, structural modeling and analysis of various tall building systems; structural design of tall buildings and case studies; other tall building aspects such as stability, fire safety, dynamic response, human response to building motions, foundation systems, construction/base isolation techniques, wind tunnel studies, research/developments and sustainability issues.

CV8400 Road Safety

This course provides an understanding of the safety management process and the variety of tools used. Topics include: probability models of accident occurrence; estimation of safety in developing and evaluating countermeasures; methods for identifying hazardous elements; safety of road facilities: intersections, roadways, roadsides, railroad crossings and traffic control elements; driver, pedestrian and bicycle safety; applications of human factors principles; safety audits; vehicle safety; biomechanics of injuries; multidisciplinary accident investigation. 1 Credit

CV8401 Traffic Operations and Management

The course introduces topics related to the management of congestion on urban road networks. These include: capacity analysis; deterministic and stochastic models of traffic behaviour; traffic assignment models; incident detection and management; ramp metering; signal timing for networks and arterials; Applications of Intelligent Transportation Systems; demand management. Antirequisite: CVL902. 1 Credit

CV8403 Transportation Planning

This course deals with the process and techniques of transportation planning, with emphasis on urban and regional applications. Topics include: historical development of transportation planning in North America; transportation planning framework; surveys and data collection; transportation-land use interaction; analysis and models of transportation demand; analysis and models of transportation performance; development and evaluation of transportation planning options. 1 Credit

CV8405 Pavement Design and Management

Pavement performance and distress. Theory and stress analysis of flexible and rigid pavements. Properties and characterization of paving materials. Design of flexible and rigid pavement for highways and runways. Overlay design. Reliability analysis. Flexible and rigid pavement construction. Pavement management systems. Review of design projects. Antirequisite: CVL 900. 1 Credit

CV8406 Advanced Highway Geometric Design

This course deals with the theory and practice of highway geometric design, including design controls, horizontal and vertical alignments, intersections, interchanges, and cross sections. Driver ability, vehicle performance, and safety are considered. Advanced topics such as three-dimensional sight distance, intersection control, safety audits, value engineering, design flexibility, design consistency, and reliability analysis are discussed. Unconventional topics such as intelligent transportation systems and roundabouts are also discussed. 1 Credit

CV8407 Special Topics in Transportation

The subject matter changes from year to year. The course description will be announced prior to the scheduling of the course. 1 Credit

CV8500 Advanced Satellite Positioning

Overview of satellite positioning methods; description of GPS satellite orbits; characteristics of the GPS signals; GPS signal propagation; GPS measurements errors; GPS observables; linear combination of GPS observables; GPS models for short, medium and long distances; integer ambiguity determination for one, two and three frequencies; integration of GPS and GLONASS; integration of GPS and INS; current research topics. 1 Credit

CV8501 Adv. Topics in Spatial Information Systems

This course covers such advanced issues as database management; various data models; spatial data standards and interchange, GIS data integration and software integration (e.g., OGC framework & GIS toolkits), algorithms for processing spatial and non-spatial data, basic architecture for networking GIS, characteristics of Internet GIS/mapping, and implementation and integration issues for online spatial data dissemination and GIS services. 1 Credit

CV8503 Geospatial Modeling & Visualization

This course will examine current research topics in applications of remote sensing imagery for generating and visualizing environmental models. The focus is on integration of multisource and multiscale geospatial data at a local and regional scale for dynamic and multidimensional modeling and visualization tasks in a stand-alone or web-based environment. Selected case studies in transportation, forestry, agriculture, and urban landscape are addressed. 1 Credit

CV8504 Adv. Topics in Estim. and Data Series Anal.

Concept of a random process, classification of processes, auto- and cross-correlation functions, spectral density function, sampling theorem, discrete Fourier transform and fast Fourier transform, introduction to wavelet theory, filters, Wiener filtering, Kalman filtering, relationship to least-squares estimation, practical applications. 1 Credit

CV8505 Design and Impl. of Spatial Info. Systems

This course addresses the software design and implementation problems for spatial information systems. It covers the topics of software engineering, spatial data structures, spatial search, and algorithms for processing spatial data, with practical applications. 1 Credit

CV8506 Industrial Metrology

Data acquisition systems employed for close range measurements. Close-range Photogrammetry and laser imaging. Mathematical formulations for self-calibration with geometric considerations. Bundle adjustment, DLT-type, sequential and phased methods. Photogrammetric network design and post-adjustment analysis. Processing of laser point clouds and form fitting. Industrial case studies. 1 Credit

CV8507 Satellite Remote Sensing of Urban Areas

This course examines the characteristics of high-resolution space-borne remote sensing systems and their applications for the mapping and analysis of complex urban scenes. Major topics include overview of high-resolution satellite remote sensors, multi-sensor data fusion, knowledge-based image analysis, photogrammetric processing of satellite images for 3D object extraction, intelligent change detection systems, and integration of remote sensing and 3D urban GIS. Selected case studies in urban transportation planning, land-use/land-cover mapping, human settlement management and environmental impact analysis are addressed. A lab-based term project with a research report or paper is required. 1 Credit

CV8508 Special Topics: Geomatics

The subject matter changes from year to year. The course description will be announced prior to the scheduling of the course. 1 Credit