

# CIVIL ENGINEERING (CIVL)

## **CIVL 7010 Modern Railway Engineering 3 cr**

A course in aspects of the design, construction, and operation of modern railways, examining main lines, branch lines, and terminals.

## **CIVL 7040 Analysis and Design of Freight Transport Systems 3 cr**

Overview of the structure and organization of Canada's freight transport system; measurement, analysis and forecasting of freight movements; transportation system performance; operating, service and cost characteristics of freight transport systems; design considerations for freight handling facilities; case studies in analysis and design of freight transport systems.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisite: CIVL 4840 or permission of the instructor for non-engineering students specializing in transport studies.

## **CIVL 7050 Transportation Engineering in Developing Regions 3 cr**

Aspects of transportation in developing regions that differ significantly from those of conventional North American practice. Factors and assumptions in developing region context; analysis and design of surface transportation systems and components in developing regions; special aspects of professional practice; case studies from Third World and northern Canada.

## **CIVL 7060 Analysis and Design of Passenger Transport Systems 3 cr**

Passenger travel forecasting principles and techniques; demand models; passenger transportation system performance; vehicle cycles; cost functions; congestion; evaluation; examination of case studies.

## **CIVL 7090 Water Resources Systems 3 cr**

The application of operations research/systems analysis techniques to water resources and urban and environmental systems.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisite: permission of instructor.

## **CIVL 7100 Prestressed Concrete 3 cr**

A study of the analysis and design of prestressed concrete structures; pre-tensioning; post-tensioning; importance of material properties; modern design specifications.

## **CIVL 7140 Structural Masonry 3 cr**

Masonry materials, properties and behaviour. Plain and reinforced masonry, axial load, flexure, combined loading. Design methods, building code developments, building design.

## **CIVL 7190 Solid Mechanics 3 cr**

Cartesian Tensors, analysis of stress and strain, constitutive relations, formulation and solution of problems in 2-D and 3-D elasticity, Hankel integral transforms, plasticity; yield surface and criteria, flow rule, plastic potential, hardening, viscoelasticity; creep, relaxation, basic viscoelastic models, stress-strain relations, correspondence principle.

## **CIVL 7200 Topics in Environmental Engineering 3 cr**

Includes topics such as energy and the environment, solid waste management, and environmental problems in transport. Topics are studied through case histories of contemporary issues.

## **CIVL 7210 Solid Waste Composting and Disposal 3 cr**

Advanced engineering principles related to resource recovery and solid waste disposal. Biological conversion technologies and the disposal of solid wastes are discussed in detail.

## **CIVL 7260 Behaviour of Reinforced Concrete Members 3 cr**

Study of the actual behaviour and strength of reinforced concrete members; examination of recent significant publications, correlation to research with current design specifications and codes.

## **CIVL 7300 Use of Fibre-Reinforced Polymers (FRP) in Structural Design 3 cr**

Fibre-reinforced polymers (FRP) constituents and properties; design of concrete structures internally reinforced with FRP, concrete members prestressed with FRP, externally bonded FRP laminates for strengthening and rehabilitation of structures; construction details and case studies of projects using FRP reinforcement.

## **CIVL 7340 Sustainability in Construction 3 cr**

Introduction and overview of sustainable construction and green buildings, green building assessment tools; the green building process; green building design, construction and commissioning, the economics of green buildings and future directions in sustainable construction and green buildings.

## **CIVL 7350 Topics in Advanced Structural Engineering 3 cr**

Lectures and seminars on selected advanced topics in structural engineering; current problems; implications on current research.

## **CIVL 7360 Landslides and Slope Failures: Identification, Causes, and Control 3 cr**

Slope movement types and processes in soil and rock masses; recognition and identification: factors influencing stability; field investigation and instrumentation; strength properties and their measurement; stability analysis; assessment of hazard and risk analysis; stability in open pit mining; remedial measures including stabilization, protection, and warning.

## **CIVL 7370 Advanced Construction Management 3 cr**

Strategic management of construction organizations; strategy systems and processes; health and safety management; human resources management; benchmarking; financing; budgeting; value management and financial performance; and quantitative decision-making for construction organizations.

## **CIVL 7400 Finite Element Method in Engineering Mechanics 3 cr**

Review of flexibility and stiffness methods; concept of finite elements and energy formulations; various shape functions; solutions of planar and three-dimensional elasticity problems; beams, plates and shells; special problems, e.g., seepage, non-linear material.

## **CIVL 7430 Special Topics in Geotechnical Engineering 3 cr**

A tutorial approach to the study of topics in soil, rock and ice engineering not covered in the formal coursework.

## **CIVL 7450 Soil Properties and Behaviour 3 cr**

Testing methods for strength, compressibility and hydraulic conductivity of engineering soils; traditional models for soil characterization; introduction to hypoelastic and elastic plastic modelling; extension of models to account for strain-rate, temperature, and unsaturation; influence of soil chemistry; relationship between laboratory results and computational needs.

## **CIVL 7460 Geotechnical Design with Geosynthetics 3 cr**

Properties and test methods of geosynthetics (i.e., geotextiles, geogrids, geomembranes, geonets and geocomposites); functions of geosynthetics (separation, reinforcement, filtration, drainage and containment); design of reinforced soil structures (retaining walls, slopes, embankments and unpaved roads); design of filtration and drainage works; design of lined waste containment facilities; case histories.

**CIVL 7480 Soils Engineering 3 cr**

Analysis and design for construction in engineering soils: review of soil strength and compressibility, site characterization, stability and settlements of shallow foundations, deep foundations, earth retaining structures, slope design and remediation, earth dams. Emphasis will be placed on published records comparing predictions with field performance.

**CIVL 7610 Special Topics in Theoretical and Applied Mechanics 3 cr**

Lectures and seminar on selected advanced topics in the field of mechanics; current problems and research.

**CIVL 7650 Selected Topics in Water-Resources Development 3 cr**

Lectures and seminars on selected advanced topics in water-resources engineering.

**CIVL 7652 River Ice Engineering 3 cr**

This course will provide students with an introduction to River Ice Engineering topics and principles. River ice processes such as freeze-up, ice growth, break-up and jamming will be explained in detail. The effects of ice on river hydraulics and hydraulic systems operation will be investigated. River and lake ice mechanics, ice safety and ice mitigation strategies will be discussed. Where possible, students will have an opportunity to gain practical experience through labs and project work.

**CIVL 7654 Advanced Hydraulics 3 cr**

This course provides an introduction to advanced hydraulics, including physical hydraulic modelling, sediment transport (cohesive and non-cohesive) and analysis and design of several different types of hydraulic structures. Additional advanced topics such as coastal engineering and fish passage will be covered as appropriate.

**CIVL 7656 Advanced Fluid Mechanics 3 cr**

Introduce concepts in advanced fluid mechanics including topics in theoretical fluid mechanics, experimental fluid mechanics and environmental fluid mechanics.

**CIVL 7658 Computational Hydraulics 3 cr**

Introduce concepts and procedures for the computational modelling of open channel hydraulic engineering problems including numerical methods and best modelling practices.

**CIVL 7660 River Engineering 3 cr**

Classification of rivers; regime of river channels; channel patterns, sediment transport; design of stable channels; engineering interference (diversions, dams, dredging); river training works; hydraulic-model studies of rivers.

**CIVL 7680 Soil/Ground Improvement Techniques 3 cr**

Analysis and design of mechanical and chemical treatment techniques commonly applied to problem foundation soils for civil engineering structures. Mechanical modification; hydraulic modification; modification by admixtures; modification by reinforcement and confinement; in-situ evaluation of soil improvement and monitoring.

**CIVL 7700 Water Resources Planning 3 cr**

Principles and methodologies of planning water resources development projects. An evaluation of a major multi-purpose project from interdisciplinary viewpoints, incorporating those of designers, planners, critics and political decision makers.

**CIVL 7710 Coastal Hydraulics 3 cr**

Mechanics of wave motion; wave and water level predictions; types and design of coastal protection; littoral processes.

**CIVL 7720 Groundwater and Solute Transport Modelling 3 cr**

The physics and numerical solution of mathematical models of steady-state and transient groundwater flow and mass transport in the saturated and unsaturated zones; introduction to the finite difference and finite element methods; popular software; other modelling techniques, including random-walk particle methods; modelling groundwater contamination; non-linear problems; applications to regional groundwater flow and groundwater recharge, aquifer resource evaluations, contamination prediction.

**CIVL 7730 Groundwater Engineering 3 cr**

The role of geology and hydrogeology in the siting, design of engineering structures; synthesis of groundwater mechanics in various geologic environments; case studies in construction dewatering, groundwater resource evaluation, subsidence, seepage in dams and foundations and slope stability; basic review of analytic solutions and numerical methods.

**CIVL 7740 Special Topics in Hydrology 3 cr**

Selected topics examining the statistical aspects of hydrology. Time series analysis; disaggregation processes; flood frequency analysis; analysis of extremes.

**CIVL 7750 Advanced Civil Engineering Systems 3 cr**

Optimization of Civil Engineering Systems. Use of linear and dynamic programming and network theory in all aspects of civil engineering. Introduction to the use of stochastic processes in operations research. Particular emphasis is given to water resources and environmental and transportation engineering.

**CIVL 7760 Recent Developments in Bridge Engineering and Structural Health Monitoring 3 cr**

Introduction to Intelligent Sensing for Innovative Structures (ISIS); Introduction to Civionics and Structural Health Monitoring; Sensors and Data Acquisition Systems; Theoretical Evaluation of Bridge Decks; Theoretical Evaluation of Cantilever Slabs; Theoretical Evaluation of Girders; Theoretical Evaluation of Columns; Bridge Inspections and Maintenance; Conceptual Design and Aesthetic Design of Bridges.

**CIVL 7770 Hydrological Processes 3 cr**

Runoff generation and runoff modelling; scale effects in hydrology; ramifications of distributed and lumped approaches; computer models of watershed modelling; optimization schemes and minimization functions; special concerns dealing with digital elevation models.

**CIVL 7776 Advanced Concrete Technology 3 cr**

Advanced properties of concrete are introduced through studying key constituent materials (e.g. cement, mineral and chemical admixtures). Concepts of design and control of concrete mixtures are described through defining performance criteria in the field. Characteristics and applications of special concretes (e.g. high-performance and self-consolidating concrete) are covered. Each topic is discussed with respect to mechanisms of action, construction specifications and requirements in Canadian and American standards.

**CIVL 7778 Durability of Concrete 3 cr**

Durability of concrete as a material. Deterioration of concrete in the field due to various damage mechanisms. Frost damage, corrosion of reinforcement, sulfate attack, etc. Durability-based design requirement in building codes.

**CIVL 7780 Advanced Behaviour and Design of Steel Structures 3 cr**

Behaviour and design of welded thin-walled members; plate girders, composite construction, beam-columns, and connections. Special topics such as stability of metal structures and bracing requirements are also covered.

**CIVL 7790 Pavement Evaluation and Performance 3 cr**

Pavement classification, pavement management, performance measures, condition surveys, sensor technology, material sampling, test methods on asphalt binders and unbound layers, non-destructive testing, sources of variability, pavement maintenance, rehabilitation, long-term performance.

**CIVL 7800 Design of Light Industrial Steel Buildings 3 cr**

Design criteria for metal building systems; behaviour and design of tapered and prismatic built-up columns and girders; design of gable frames; behaviour and design of cold-formed members; bracing requirements for metal buildings and design of connections.

**CIVL 7810 Flow and Transport in Fractured Rock 3 cr**

The physics and numerical solution of mathematical models of flow and transport processes in fractured rocks; scale effects; single, dual, and mixed modelling techniques; heat flow and transport in fractured rock systems; applications to local and regional groundwater flow.

**CIVL 7820 Operational Hydrology 3 cr**

Hydrographic analysis; relation between the physical processes and the hydrograph; estimation and prediction. Floods; statistical analysis; maximum probable floods. Water supply; estimates of dependable flow, simulation, synthetic flow series, statistical analysis.

**CIVL 7840 Traffic Systems Analysis 3 cr**

Mathematical theories of traffic flow, introductory queueing theory with application to traffic performance at intersections; travel forecasting principles and techniques; the use of simulation in traffic engineering design.

**CIVL 7850 Advanced Structural Dynamics 3 cr**

Responses of single-degree-of-freedom and multi-degree-of-freedom systems, damped and undamped systems, linear and inelastic systems to dynamic excitations; free vibration, forced vibrations. Special emphasis on responses of civil structures to seismic and blast loadings.

**CIVL 7870 Advanced Engineering Analysis 3 cr**

Analytical techniques used in engineering, including such topics as the application of complex variables, partial differential equations, generated Fourier series, integral transforms, and special functions, to advanced problems in civil engineering.

**CIVL 7920 Theory of Water Treatment 3 cr**

Physical and chemical characteristics of water; water treatment processes including coagulation/flocculation, sedimentation, filtration, softening, adsorption, ion exchange, disinfection, and membrane processes.

**CIVL 7930 Theory of Waste Treatment 3 cr**

Characteristics of waste-specific and generic determinations; unit operations and unit process for physical, chemical and biological treatment and transformation of particulate and dissolved contaminants. Biochemical transformations and degradation of hazardous pollutants; unit processes for enhanced nutrient removal and hazardous waste treatment. Full treatment trains for industrial and municipal waste treatment, including solids handling.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisite: CIVL 3700 and CIVL 3690 or permission of instructor.

**CIVL 7950 Environmental Engineering Laboratory 3 cr**

Laboratory work in water and wastewater analysis and treatment processes related to water quality management.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisites: CIVL 7930 and CIVL 7920.

**CIVL 7960 Environmental Engineering Design 3 cr**

Design of unit operations. Planning, cost effectiveness analysis, and conceptual design of a whole wastewater treatment plant.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisites: CIVL 7930.

**CIVL 7990 Special Topics in Transportation 3 cr**

Lectures and seminars on selected topics in transportation not covered in the formal coursework.