CIVIL ENGINEERING (CIVL)

CIVL 200 Professional Skills I Units: 2.50
This intensive short-course serves as a kickoff to Civil Engineering at Queen's. Students will be engaged in a design challenge where they are to conceive, design, implement and operate a system to achieve some specified function bounded by constraints. Focus will be placed on development of decision making, team building, communication and engineering design skills.
K2.5(Lec: Yes, Lab: No, Tut: No)
Requirements: Prerequisites: Must be registered in BSCE or BASC program. Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 8
Engineering Science 0
Engineering Design 20
Offering Faculty: Smith Engineering
Course Learning Outcomes:

1. Demonstrates effective oral presentation skills.
2. Demonstrates ability to work effectively as a member in a team.
3. Seek and integrate diverse and alternative viewpoints in decision-making.
4. Write with conciseness, precision and clarity.
5. Identify and define problems.
6. Create figures, maps, tables and drawings to engineering report standards.
7. Develop appropriate solutions and strategies to problem solve.
8. Evaluate performance of a design, using criteria that incorporates specifications, limitations, assumptions, constraints, and other relevant factors.
9. Adhere to appropriate workplace safety protocols in shop and field work environments.
10. Intentionally incorporate principles of fairness, access and opportunity into decision making.
11. Share ideas and information by eliciting, giving, and applying positive and effective feedback.
12. Identify effective leadership traits.

CIVL 201 Professional Skills Units: 2.50
Within a team structure potentially involving second, third, and fourth year Civil Engineering students and a faculty advisor, students will engage in a range of exercises designed to promote written and verbal communication, decision making, team building and engineering design skills. Lectures, workshops, design charettes and both individual and team assignments will be utilized to enhance learning. This course is available only to select students, under exceptional or extenuating circumstances, at the discretion of the Head of the Department and the Undergraduate Chair. (This course may not be offered every year).
(Lec: 0.5, Lab: 1, Tut: 1)
Requirements: Prerequisites: Permission of the Department Corequisites: Exclusions: CIVL 200
Offering Term: FW
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 14
Engineering Science 7
Engineering Design 7
Offering Faculty: Smith Engineering

CIVL 210 Chemistry For Civil Engineers Units: 4.50
Application of fundamental chemistry principles with respect to their sources, reactions, effects and fates in civil and environmental engineering systems. Topics will include chemical equilibria, stoichiometry and reaction kinetics; electrochemistry and corrosion; adsorption and ion exchange; solubility and precipitation; coagulation; microbiological reactions and kinetics; biochemical, chemical and theoretical oxygen demand; acidity, alkalinity and hardness; as well as biogeochemical cycles. These concepts will be further developed and applied in tutorial and laboratory modules. A design-based laboratory is conducted as part of this course. Personal Protective Equipment (PPE) will be required for this course at student's cost (see course materials for details)
(Lec: 3, Lab: 1, Tut: 0.5)
Requirements: Prerequisites: APSC 132 Corequisites:
Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 20
Complementary Studies 0
Engineering Science 20
Engineering Design 15
Offering Faculty: Smith Engineering
Course Learning Outcomes:

1. Understand workplace safety protocols.
2. Describe chemical concepts, parameters and processes in civil and environmental engineering, including those related to electrochemistry, precipitation, alkalinity, biological chemistry, and equilibrium partitioning.
3. Analyze chemical data related to water quality and water treatment.
4. Solve problems in civil and environmental engineering using chemical concepts.
5. Design bench-scale proof-of-concept passive and active treatment systems to mitigate the effects of chemical constituents.

CIVL 215 Materials For Civil Engineers Units: 4.50
The basic engineering properties, micro/macro structure, behaviour and applications of various civil engineering materials will be studied including materials used in structural engineering, hydrotechnincal engineering, geotechnical engineering and environmental engineering. This will include concrete, steel, timber, polymers, composites and soil. Interaction between materials will be examined. Laboratory experiments will be used to demonstrate material behaviour. PPE will be required for this course student's cost (see course materials for details)
(Lec: 3, Lab: 1, Tut: 0.5)
Requirements: Prerequisites: APSC 151 Corequisites:
Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Science 32
Engineering Design 10
Offering Faculty: Smith Engineering
Course Learning Outcomes:

1. Understand how material strength is assessed and how it is used in civil design.
2. Understand how material stiffness is assessed.
3. Design concrete mixtures using absolute volume method.
4. Correlate the microstructure of metals to their mechanical properties.
5. Understand the nature of soil material based on their origin, classification, and physical properties.
6. Become familiar with polymers and their applications in Civil Engineering.
7. Understand introductory geosynthetics and their applications in Civil engineering.
8. Take initiative to plan, organize and complete tasks, as an individual and team member, in order to meet goals.
9. Produce clear, concise, precise and well#organized written communication with language appropriate for the audience.
10. Adhere to laboratory safety protocols.

CIVL 222 Numerical Methods Units: 5.00
This course introduces the basics of numerical analysis and the use of computer software (MATLAB) for civil engineering analysis. Error analysis, numerical differentiation and integration, root finding, derivation and numerical solution of partial differential equations using finite difference methods, and optimization are among the topics covered. All problems emphasize engineering applications.
(Lec: 4, Lab: 0, Tut: 1)
Requirements: Prerequisites: MTHE 224 (MATH 224) or MTHE 225 (MATH 225) or MTHE 226 (MATH 226) Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 45
Natural Sciences 0
Complementary Studies 0
Engineering Science 15
Engineering Design 0
Offering Faculty: Smith Engineering
Course Learning Outcomes:

1. Understand the roles of numerical solution and analytical solution of mathematical problems.
2. Understand how common numerical algorithms are derived.
3. Select and appropriate method for numerical solution of specific mathematical problems such as optimization, solving a system of linear equations or ordinary differential equations, etc.
4. Write computer code and employ library software (in MATLAB environment) to implement numerical algorithms.

CIVL 230 Solid Mechanics I Units: 4.25
Graphic Statics; Definitions of Stress and Strain; Hooke's Law; Axial Member Analysis and Design; Analysis and Design of Shafts Subjected to Torsion; Analysis and Design of Beams; Columns; Inelastic Bending; Introduction to Work and Energy and the Principle of Virtual Work
(Lec: 3, Lab: 0, Tut: 1.25)
Requirements: Prerequisites: APSC 111, APSC 171, APSC 182 Corequisites: Exclusions: MECH 221
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 50
Engineering Design 0
Offering Faculty: Smith Engineering
Course Learning Outcomes:

1. Calculate the stress and deflections of axial members.
2. Calculate the stress and deflections of a beam.
3. Calculate the stress and rotations of a circular shaft under torsion.
4. Calculate the buckling capacity of an elastic column.
5. Calculate the plastic moment of a beam.
6. Calculate deflection of a truss using the Principle of Virtual Work.

CIVL 231 Solid Mechanics II Units: 4.50
Shear and bending moment diagrams; Moment-area method; Introduction to statically indeterminate structures; Virtual work for beams and frames (determinate and indeterminate); Stress review, transformed sections, and combined loading; Stress-strain transformation (including Mohr's circle); Failure theories.
(Lec: 3, Lab: 0.5, Tut: 1)
Requirements: Prerequisites: CIVL 230 Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 54
Engineering Design 0
Offering Faculty: Smith Engineering
Course Learning Outcomes:

1. Employ free body diagrams as a tool to identify unknown forces.
2. Calculate unknown forces using equations of equilibrium.
3. Solve for deflections using the moment-area method.
4. Solve statically indeterminate frames using the force method.
5. Explain how thermal loading affects the loads, stresses, and deflections of a structure.
6. Calculate deflections and rotations of beams and frames (determinate and indeterminate).
7. Draw shear force and bending moment diagrams for statically indeterminate structures.
8. Select the appropriate stress equation for the member being analyzed.
9. Calculate the stress in a section made of a composite material.
10. Given a combined loading scenario, calculate the maximum reaction forces and stresses on a structure.
11. Given a set of stresses, calculate the critical stresses acting on a given cross section.
12. Given a set of stresses, apply failure theories to determine if a structure made of a given material (concrete, steel, FRPs) is fit for purpose.
13. Calculate the magnification factor associated with dynamic loads acting on a structure (impact loading).

CIVL 232 Structural Analysis Units: 4.25
Review of statics; concepts of stress and strain; mechanical properties of materials; Hooke's Law; axial stress; flexural stress; centroids and moments of areas; shear stress in shafts and beams; calculation of beam displacement by integration; introduction to combined loading; introduction to column buckling, introduction to plastic moments, introduction to the Principle of Virtual Work to calculate truss deflections.
(Lec: 3, Lab: 0, Tut: 1.5)
Offering Term: S
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 50
Engineering Design 0
Offering Faculty: Smith Engineering
Course Learning Outcomes:

1. CLOs coming soon; please refer to your course syllabus in the meantime.

CIVL 250 Hydraulics I Units: 4.00
Fluid properties, fluid statics, basic equations of fluid flow: Continuity, Momentum, Euler's Equation of Motion, Linear Momentum Equation and Bernoulli's Equation. Flow of real fluid in closed conduits: friction losses and local energy losses. Pipeline flows in engineering practice. PPE will be required for this course at student's cost (see course materials for details)
(Lec: 3, Lab: 0.5, Tut: 0.5)
Requirements: Prerequisites: APSC 172, APSC 174
Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 4
Complementary Studies 0
Engineering Science 22
Engineering Design 22
Offering Faculty: Smith Engineering
Course Learning Outcomes:

1. Acquire an overall understanding of the scope of fluid mechanics in the context of civil engineering practice.
2. Understand what constitutes a fluid and gain knowledge of fluid properties.
3. Understand how pressure is distributed in a fluid and learn how to quantify forces caused by a static fluid on infrastructure.
4. Gain knowledge about different types of fluid motion (flow classification) and learn how to visualize flow.
5. Understand the basic laws governing fluid motion, including continuity equation, linear momentum equation, the angular momentum theorem and the energy equation.
6. Develop an understanding of how to apply the laws governing fluid motion to the solution of practical problems in the practice of civil engineering (e.g., conduct water balances, quantify boundary shear stresses and forces caused by moving fluids, design simple pipeline systems and hydraulic circuits).
7. Acquire familiarity with different methods of measuring pressure, velocity and flow rate.

CIVL 300 Professional Skills II Units: 2.50
Professional skills relating to how engineers interact with, communicate with, and consider the implications of their actions on a wide range of potential stakeholders, ranging from colleagues to clients to society as a whole, will be developed. Students will improve their technical writing and verbal communication skills as they work through case studies intended to: deepen an understanding of the roles and responsibilities of a Professional Engineer; strengthen an ability to apply professional ethics, accountability and equity; and enhance an appreciation of the potential social and environmental impacts of engineering activities. Class discussions will normally occur every second week.
K2.5(Lec: Yes, Lab: No, Tut: No)
Requirements: Prerequisites: CIVL 200 Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 28
Engineering Science 0
Engineering Design 0
Offering Faculty: Smith Engineering
Course Learning Outcomes:

1. Demonstrate the ability to work effectively as a member of the team.
2. Write with conciseness, precision, and clarity.
3. Identify and explain the roles and responsibilities of a professional engineer.
4. Assess how stakeholder impact might alter/constrain an engineering activity.
5. Identify and evaluate an ethical dilemma following a Professional Engineer’s Code of Ethics.
6. Give and respond to clear instructions.

CIVL 330 Structural Analysis Units: 4.00
Analysis of statically determinate structures such as trusses and plane frames, calculation of deflections by virtual work. Flexibility and stiffness methods for analyzing statically indeterminate structures. Computer applications of the above methods.
(Lec: 3, Lab: 0.5, Tut: 0.5)
Requirements: Prerequisites: CIVL 230, CIVL 231
Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 48
Engineering Design 0
Offering Faculty: Smith Engineering
Course Learning Outcomes:

1. Analyse structures using the load combinations specified by the National Building Code of Canada.
2. Analyse structures using the matrix method.
3. Determine stability and analyse structures using the force method.
4. Analyse indeterminate structures using displacement methods (slope-deflection equations).
5. Analyse structures using a commercial software package.

CIVL 331 Structural Steel and Timber Design Units: 4.00
The objective of this course is to develop an understanding of the fundamentals in the design of steel and timber structures. To develop this understanding, the course focuses in-depth on the behaviour of steel and timber at the material, element, and system levels with specific reference to standards/codes practicing engineers use when designing with steel and timber in Canada, including CSA S16 and CSA O86. Students will learn how to design and analyze steel and timber tension members, columns, beams (laterally supported and laterally unsupported), beam-columns, and connections.
(Lec: 3, Lab: 0, Tut: 1)
Requirements: Prerequisites: CIVL 330 Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 12
Engineering Design 36
Offering Faculty: Smith Engineering
Course Learning Outcomes:

1. Design axially loaded (tension and compression) members.
2. Design bolted connections for tension members.
3. Design welded connections in steel tension members.
4. Design slender steel columns considering buckling.
5. Design laterally supported and unsupported beams.
6. Analyze beam-columns for cross-sectional, overall, and torsional buckling strength.

CIVL 340 Geotechnical Engineering 1 Units: 4.00
An introductory course focussing on the fundamental mechanics of soil materials (gravel, sand, silt and clay) applied to geotechnical engineering problems. Topics studied include: phase relationships; index properties of coarse and fine grained soils; one-dimensional steady state seepage; effective stress; one-dimensional compression and consolidation; drained and undrained shear strength; and lateral earth pressure. Theoretical material is applied to examine real engineering issues with a particular focus on developing design skills and engineering judgement. Students will conduct physical experiments to explore soil behaviour. The important role of geology on the mechanics of geotechnical materials is emphasized through classroom discussions and problem sets. PPE will be required for this course at student's cost (see course materials for details).
(Lec: 3, Lab: 0.5, Tut: 0.5)
Requirements: Prerequisites: CIVL 215 or GEOE 281, CIVL 230 Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 36
Engineering Design 12
Offering Faculty: Smith Engineering
Course Learning Outcomes:

1. Identify soil type and likely engineering behaviour from index properties.
2. Explain the effects of soil type, water content and energy on soil compaction.
3. Calculate effective stress.
4. Infer pressure heads for layered systems.
5. Understand drained and undrained shear strength.
6. Calculate settlement for change in effective stress.
7. Calculate rate of settlement.
8. Obtain geotechnical parameters from laboratory tests.
9. Observe and explain soil behaviour through hands on physical observations.
10. Adhere to laboratory safety protocols.
11. Design solution to open-ended geotechnical problem.

CIVL 341 Geotechnical Engineering 2 Units: 4.00
A course focusing on design issues and methods of analysis for practical geotechnical engineering problems. Topics studied include: site investigation; capacity and settlement of shallow and deep foundations; two-dimensional steady state seepage; landslides and slope stability. Commercial software will be introduced to perform stability, deformation and seepage analyses. Students will conduct physical experiments to explore how design methods compare with real soil behaviour. The important role of geology in geotechnical design is emphasized through classroom discussions and problem sets. PPE will be required for this course at student's cost (see course materials for details)
(Lec: 3, Lab: 0.5, Tut: 0.5)
Requirements: Prerequisites: CIVL 340 Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 12
Engineering Design 36
Offering Faculty: Smith Engineering
Course Learning Outcomes:

1. Knowledge of the appropriate use of sampling methods and in-situ tests to perform site characterization and obtain geotechnical design parameters.
2. Familiarity with typical deep and shallow foundation system options.
3. Ability to conduct geotechnical stability and settlement analyses for shallow & deep foundations under drained and undrained conditions.
4. Ability to explain the various contributory causes of landslides and to identify the relevance of drained or undrained analyses to the analysis of the proximate cause.
5. An understanding of limit equilibrium slope analyses methods evidenced through the ability to derive infinite slope stability equations, and the ability to conduct 2D seepage analyses in combination with effective stress analysis of slopes.
6. Knowledge of the concept of active and passive earth pressure and the relevance of each to design of retaining walls.
7. Calculate the stability of gravity and flexible retaining walls.

CIVL 350 Hydraulics 2 Units: 4.00
Topics in open channel flow including friction, specific energy, free-surface profiles, culverts and hydraulic-jump energy dissipaters. Lake dynamics and environmental hydraulics will be introduced. The basic underlying concepts of water resources and hydrology will be discussed.
(Lec: 3, Lab: 0.5, Tut: 0.5)
Requirements: Prerequisites: CIVL 250 Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 18
Engineering Design 30
Offering Faculty: Smith Engineering
Course Learning Outcomes:

1. Simulate flow in open channels using HEC-RAS model.
2. Apply conservation of energy and momentum concepts to analyze and design rapidly varied flow transitions in open channels.
3. Calculate and sketch gradually varied flow profiles in open channels.
4. Apply advection, diffusion and dispersion concepts to calculate mixing and transport of scalar variables in rivers.
5. Apply hydrology concepts to compute the flow rate in open channels

CIVL 360 Civil Engineering Design and Practice III Units: 4.00
Students will develop and employ Engineering Design and Practice skills to resolve a complex, open-ended design task. This will involve the iterative application of Civil Engineering technical knowledge to identify and evaluate design options. The economic, environmental and societal implications of the preferred solution(s) will be assessed. Students will select, detail and communicate their final design in a logical, traceable and defendable manner. Ethical, legal and other relevant professional issues will be studied and discussed through case studies. Students will also develop and enhance written, graphical and oral communications skills.
K4(Lec: Yes, Lab: No, Tut: Yes)
Requirements: Prerequisites: APSC 200 Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 12
Engineering Science 0
Engineering Design 36
Offering Faculty: Smith Engineering
Course Learning Outcomes:

1. Applies appropriate creative and/or innovative approaches to the design.
2. Generates a traceable and defensible record of a technical project using an appropriate project records system.
3. Addresses risk, standards, codes of practice, legal, regulatory, compliance, environmental and social factors.
4. Demonstrates conciseness, precision and clarity of language in technical writing.
5. Uses graphics to explain, interpret and assess information.
6. Demonstrate ability to work effectively as a member in a team.
7. Applies and communicates the appropriate methods throughout the design process.
8. Explicitly defines the problem and applies constraints to guide the process toward an optimal solution.
9. Follows appropriate iterative engineering design process to resolve problem.
10. Develops the detailed criteria to measure performance and ensure compliance subject to constraints, assumptions and other factors relevant to all stakeholders.
11. Identify, compare and contrast multiple strategies for solving a problem.
12. Share ideas and information by eliciting, giving and applying positive and effective feedback.

CIVL 371 Groundwater Engineering Units: 4.00
This course introduces students to the fundamentals of groundwater systems with an emphasis on the engineering design of extraction systems for water supply, site dewatering, and parameter estimation tests. Source water protection methods will be discussed. Equations governing the flow of groundwater, flownets, and capture zones are presented. Detailed case histories are presented. Laboratories make extensive use of commercial grade software for surface and groundwater flow simulation.
(Lec: 3, Lab: 0.5, Tut: 0.5)
Requirements: Prerequisites: MTHE 224 or MTHE 225 or MTHE 232 Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 34
Engineering Design 14
Offering Faculty: Smith Engineering
Course Learning Outcomes:

1. Assess 2D groundwater flow using graphical flow nets, experiments, and simulations.
2. Calculate distributions of hydraulic head in homogeneous and layered porous media.
3. Calculate groundwater flux, velocity, and flow direction in 1D and 2D.
4. Adhere to field and laboratory safety protocols.

CIVL 372 Water and Wastewater Units: 4.00
The focus of this course is to introduce water and wastewater engineering systems through active learning strategies and hands-on lab experiences. Students will have the opportunity to learn about environmental indicators/measurements/ guidelines, reactors, engineered and natural systems, biological and chemical reactions, mass and energy balances, risk assessment, life cycle assessment, and environmental and human health impact assessment. These concepts will allow students to assess a variety of aspects of environmental engineering and design.
(Lec: 3, Lab: 1, Tut: 0)
Requirements: Prerequisites: CIVL 210 Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Science 20
Engineering Design 16
Offering Faculty: Smith Engineering
Course Learning Outcomes:

1. Asses multiple environmental systems.
2. Apply concepts to both engineered and natural systems in environmental engineering.
3. Calculate and integrate spatial and temporal elements of a system.
4. Evaluate the key components of a systems in order to make recommendations (design, regulatory, policy).

CIVL 400 Professional Skills III Units: 2.50
Professional skills relating to how engineers interact with, communicate with, and consider the implications of their actions on a wide range of potential stakeholders, ranging from colleagues to clients to society as a whole, will be developed. Students will improve their technical writing and verbal communication skills as they work through case studies intended to: deepen an understanding of the roles and responsibilities of a Professional Engineer; strengthen an ability to apply professional ethics, accountability and equity; and enhance an appreciation of the potential social and environmental impacts of engineering activities. Class discussions will normally occur every second week.
K2.5(Lec: Yes, Lab: No, Tut: No)
Requirements: Prerequisites: CIVL 300 Corequisites: CIVL 460 Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 28
Engineering Science 0
Engineering Design 0
Offering Faculty: Smith Engineering
Course Learning Outcomes:

1. Write with conciseness, precision, and clarity.
2. Identify effective leadership traits.
3. Identify and explain the primary roles of a professional engineer.
4. Consider and respond to perceived stakeholder impact to alter/constrain an engineering activity.
5. Evaluate and resolve an ethical dilemma following the Professional Engineer's Code of Ethics.
6. Reflect on own education to-date and identify new knowledge and skills required to resolve complex technical issues.
7. Give and respond to clear instructions.

CIVL 430 Reinforced Concrete Design Units: 4.00
Flexural design of reinforced concrete beams including singly reinforced sections, doubly reinforced sections, T-sections, and one-way slabs. Control of cracking in reinforced concrete beams as specified for design. Design of continuous beams and one-way slabs; short and slender columns; footings deflections; development of reinforcement. A laboratory design project is undertaken in this course. PPE will be required for this course at student's cost (see course materials for details).
(Lec: 3, Lab: 0.5, Tut: 0.5)
Requirements: Prerequisites: CIVL 215, CIVL 330, CIVL 331 Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 12
Engineering Design 36
Offering Faculty: Smith Engineering
Course Learning Outcomes:

1. Calculate the ultimate moment capacity of a reinforced concrete beam.
2. Design of a reinforced concrete beam in flexure using CSA A23.3.
3. Design of a reinforced concrete beam in shear using CSA A23.3.
4. Construct interaction diagrams to design and analyze short and slender columns.
5. Analyze continuous concrete beams and one-way slabs using moment and shear coefficients from the Concrete Design Handbook.
6. Design isolated footings using reinforce concrete considering failure modes.
7. Calculate deflection of cracked RC beams using effective moment of inertia.
8. Design, construct, and test to failure concrete beams with varying reinforcement ratios.

CIVL 431 Infrastructure Rehabilitation Units: 4.00
This course deals with evaluation of the deterioration of the infrastructure and the design of rehabilitation measures. Items discussed include corrosion of reinforcement in concrete, microbiological corrosion of buried pipelines, asphalt deterioration and repair, deterioration of timber in buildings, and issues of sustainability of infrastructure. Design techniques to reduce deterioration in new construction are also discussed. The laboratory portion involves some of the test methods used to evaluate deterioration and field trips to observe some common forms of deterioration. PPE will be required for this course at student's cost (see course materials for details)
(Lec: 3, Lab: 0.5, Tut: 0.5)
Requirements: Prerequisites: CIVL 430 Corequisites:
Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 32
Engineering Design 16
Offering Faculty: Smith Engineering
Course Learning Outcomes:

1. Describe the need for infrastructure rehabilitation in Canada
2. Identify alternatives for rehabilitating buried infrastructure
3. Design micropiles to support structures.
4. Describe deterioration mechanisms that lead to reductions in strength.
5. Evaluate, repair, and test to failure deteriorated and rehabilitated beams with varying rehabilitation strategies.
6. Calculate reduced moment capacity due to corroded steel.
7. Explain the three roles of a building envelope and what each element does.
8. Synthesize an infrastructure rehabilitation topic and report on it.

CIVL 436 Prestressed Concrete Units: 4.00
Behaviour, analysis and design of pretensioned and post-tensioned concrete systems including simply-supported and continuous beams, and two-way slabs. Considerations of prestress losses, cracking and deflection. A design project is undertaken in this course. Three term-hours, winter; lectures and tutorials.
(Lec: 3, Lab: 0, Tut: 1)
Requirements: Prerequisites: CIVL 430 Corequisites:
Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 24
Offering Faculty: Smith Engineering
Course Learning Outcomes:

1. Calculate the camber and/or deflection of prestressed concrete beam.
2. Design a prestressed beam based on serviceability requirement.
3. Calculate ultimate moment capacity of a prestressed concrete beam.
4. Calculate the primary and secondary moment in continuous prestressed beam.

CIVL 442 Geotechnical Design Units: 4.00
A design-based course where geotechnical principles are applied to study the design of a variety of geotechnical engineering structures. Topics studied include: design of a site investigation program, interpretation of site stratigraphy, estimation of soil parameters, design of shallow and/or deep foundations, design of earth retaining structures, and construction issues such as dewatering schemes or temporary excavations. Students will conduct practical design tasks to experience a range of aspects of the geotechnical design process, to utilize common models used in geotechnical design, and to communicate with project partners such as structural consultants, site investigation companies, and construction contractors. The important role of geology in geotechnical problems is emphasized through classroom discussions, planning a site investigation and constructing a geologic model.
(Lec: 3, Lab: 0, Tut: 1)
Requirements: Prerequisites: CIVL 341 Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 12
Engineering Design 36
Offering Faculty: Smith Engineering
Course Learning Outcomes:

1. Select appropriate geotechnical model and parameters.
2. Assess groundwater conditions and incorporate into geotechnical stability assessment.
3. Construct geologic site model by designing a site investigation and interpreting results.
4. Design geotechnical elements and systems that satisfy required limit states.

CIVL 443 Geoenvironmental Design Units: 4.00
A design-based course where geotechnical and hydrogeologic principles are applied to study environmentally sustainable disposal of solid waste. Topics studied include: source and nature of waste: disposal options; environmental legislation and regulations; public impact and perception; contaminant transport; use of geosynthetic materials; and design issues and tradeoffs. Students will conduct practical design tasks to investigate the planning, design, construction, operation and post-closure of phases of an engineered waste disposal facility. The important role of geology in geoenvironmental problems is emphasized through classroom discussions, planning a site investigation and constructing a geologic model.
(Lec: 3, Lab: 1, Tut: 0)
Requirements: Prerequisites: CIVL 340 or permission of the department Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 12
Engineering Design 36
Offering Faculty: Smith Engineering
Course Learning Outcomes:

1. Apply Provincial regulations for new municipal solid waste landfills.
2. Construct geologic site model by designing a site investigation and interpreting results.
3. Assess local and regional groundwater conditions and incorporate into contaminant impact assessment.
4. Calculate one-dimensional advective flow through natural and engineered layered systems.
5. Identify dominant contaminant transport mechanism(s) through fine and coarse-grained soils, and geosynthetic liners.
6. Identify the critical contaminant(s) of potential waste stream.
7. Calculate contaminant impact on receptor aquifer from waste containment facility.
8. Design a barrier system for a waste containment facility that meets Provincial environmental regulations and satisfies current and anticipated needs of a hypothetical municipality.
9. Incorporate service life implications of engineered components on barrier system performance.

CIVL 450 Municipal Hydraulics Units: 4.00
The course will present concepts and tools to analyze and design water services, including storm sewers, sanitary sewers, and water mains, at the site- and sub-division level. Many of the concepts and tools are used in the fields of land-development engineering and municipal engineering. The course will provide an interoduction to hydrological processes, design rainfall prediction with intensity-duration-frequency curves, estimation of time of concentration, peak runoff prediction in small drainage areas with the Rational Method and the unit hydrograph method, reservoir routing and storm water management tank and pond design, storm sewer analysis and design with Manning's equation, wastewater flow prediction, sanitary sewer analysis and design, water demand prediction, steady-state analysis of pressurized pipes, water main design, and designing water services according to municipal design standards.
(Lec: 3, Lab: 0, Tut: 1)
Requirements: Prerequisites: CIVL 350 Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 12
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 12
Offering Faculty: Smith Engineering
Course Learning Outcomes:

1. Use industry-standard model to analyze hydraulic conditions in storm water sewers, sanitary sewers, and water distribution pipes.
2. Design site services (sanitary, storm water and water system) for residential sub-division.
3. Perform a cost analysis of proposed sanitary, storm water, and water systems for residential sub-division.
4. Write an effective site servicing report that summarizes a proposed design for sanitary, storm water, and water servicing of a sub-division.

CIVL 451 Lake, Reservoir and Coastal Units: 4.00
The fundamental hydraulic processes affecting coastal engineering and water reservoir operation are discussed. Topics include wave theory, wave measurement, wave record analysis, wave transformation, seiches, tides, storm surges, turbulent mixing and transport of pollutants. Student projects are assigned on computational water reservoir modelling, analysis of field data and reservoir operation as well as the design of breakwaters and ocean structures and the use of hydraulic and numerical coastal models.
(Lec: 3, Lab: 0.5, Tut: 0.5)
Requirements: Prerequisites: CIVL 350, or permission of the department Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 26
Engineering Design 22
Offering Faculty: Smith Engineering
Course Learning Outcomes:

1. Apply numerical models to understand surface wave transformation.
2. Correctly apply computational engineering models to simulate lake circulation and water quality.
3. Understand effects of climate, density stratification and the Coriolis force on mixing and circulation in lakes and reservoirs.
4. Understand how coupling between hydrodynamics and nutrients affects water quality.
5. Design coastal structures including rubble mound breakwaters.

CIVL 455 River Engineering Units: 4.00
A course in the basics of river engineering including the study of alluvial processes, the prediction and consequences of sediment transport, the design of measures to control erosion and accretion, and the design of dams, spillways and diversions. Cristical aspects in the design of river engineering structures and assessment of environment impact of river engineering projects are discussed. The use of physical and numerical models in the practice of river engineering is illustrated. The principles of natural channel design, stream restoration, and bioengineering in river environments are also addressed.
(Lec: 3, Lab: 0.5, Tut: 0.5)
Requirements: Prerequisites: CIVL 350 Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 24
Offering Faculty: Smith Engineering
Course Learning Outcomes:

1. Gain knowledge of a river as an object with a movable boundary and a conveyor of a two-phase flow (water = liquid phase; sediment = solid phase).
2. Gain knowledge about the mechanical properties of flow, including shear stress and velocity distributions, and the physical properties of sediment and sediment mixtures.
3. Understand the mechanics of sediment transport, and learn to quantify bed-load and suspended-load sediment transport rates.
4. Gain knowledge of river morphological features (ripples, dunes, bars, meandering and braiding), their dynamics and implications of their occurrence.
5. Gain knowledge about common river engineering problems and solutions, including prevention of undesirable bed and/or bank erosion and deposition, prevention of stream incision, techniques for stabilization of river course, techniques for modification of river course, and principles of stream restoration and renaturalization.
6. Gain knowledge about mathematical models commonly used in river engineering practice for the simulation and prediction of river flows and their physical and environmental impacts.

CIVL 460 Civil Engineering Design and Practice IV Units: 6.00
This fourth year design capstone course has student teams undertake a comprehensive engineering design project which involves the creative, interactive process of designing a structure/system to meet a specified need subject to economic, health, safety and environmental constraints. The teams will work in collaboration with an industry partner. Each team will submit an engineering report and make an oral presentation PPE will be required for this course at student's cost (see course materials for details)
K6(Lec: Yes, Lab: No, Tut: Yes)
Requirements: Prerequisites: APSC 200, APSC 293, CIVL 360, CIVL 330, CIVL 340, CIVL 350, CIVL 371 or in final 16 months of CIVL program. Corequisites: Exclusions:
Offering Term: FW
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 12
Engineering Science 0
Engineering Design 60
Offering Faculty: Smith Engineering
Course Learning Outcomes:

1. Applies appropriate creative and/or innovative approaches to the design.
2. Generates a traceable and defensible record of a technical project using an appropriate project records system.
3. Addresses risk, standards, codes of practice, legal, regulatory, compliance, environmental and social factors.
4. Demonstrates conciseness, precision and clarity of language in technical writing.
5. Demonstrates effective oral presentation skills.
6. Uses graphics to explain, interpret and assess information.
7. Demonstrate ability to lead a team.
8. Demonstrate ability to work effectively as a member in a team.
9. Applies and communicates the appropriate methods throughout the design process.
10. Explicitly defines the problem and applies constraints to guide the process toward an optimal solution.
11. Follows appropriate iterative engineering design process to resolve problem.
12. Develops the detailed criteria to measure performance and ensure compliance subject to constraints, assumptions and other factors relevant to all stakeholders.
13. Compare multiple strategies for solving a problem.
14. Share ideas and information by eliciting, giving, and applying positive and effective feedback.

CIVL 471 Subsurface Contamination Units: 4.00
This course deals with subsurface contamination by hazardous industrial liquids such as PCB oils, gasoline, jet fuel, chlorinated solvents and coal tars. The fundamentals of multiphase/multicomponent flow and transport in soil and groundwater are outlined followed by specific treatment of both dense and light non-aqueous phase liquids. The course will examine the subsurface distribution of these liquids, site characterization methods, indoor air intrusion, regulatory apsects, remediation technologies, and selected case histories.
(Lec: 3, Lab: 0, Tut: 1)
Requirements: Prerequisites: CIVL 371, or GEOE 343 (GEOL 343), or permission of the department Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 34
Engineering Design 14
Offering Faculty: Smith Engineering
Course Learning Outcomes:

1. Assess vapour intrusion into indoor air using an industry standard mathematical screening model.
2. Characterize hazardous waste sites with respect to the presence and spatial distribution of non-aqueous phase liquids to the level of competency expected by Canadian regulators.
3. Assess the applicability of various in-situ technologies for the remediation of hazardous waste sites.

CIVL 472 Water Treatment Units: 4.00
This course describes the physical-chemical treatment processes for water treatment. Students in this course will learn about the chemical and microbiological constituents in source water that determine downstream treatment requirements. Students will explore the fundamental physical, chemical and biological principles that govern unit operations (e.g. coagulation and flocculation; screening, sedimentation, and floatation; filtration; disinfection) and their applications in water treatment plants. Students will learn about plant optimization and apply systems thinking to analyze and design water treatment scenarios. The responsibilities of a professional engineer in ensuring safe drinking water will also be discussed.
(Lec: 3, Lab: 0.5, Tut: 0.5)
Requirements: Prerequisites: CIVL 372 Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 36
Engineering Design 12
Offering Faculty: Smith Engineering
Course Learning Outcomes:

1. Describe the sources of contaminants in source water and the regulatory requirements for their removal.
2. Apply physical/chemical/biological to calculate sedimentation, floatation, coagulation, flocculation, softening, and filtration properties.
3. Determine disinfectant dose and strategy to manage microbial risks.
4. Evaluate interrelatedness of upstream and downstream unit processes.
5. Design and optimize water treatment unit processes, individually and/or as part of a water treatment train.

CIVL 473 Water Resources Systems Units: 4.00
This course will present concepts and tools for designing and modelling large-scale water resources systems in urban catchments. Focus will be placed on the design and analysis of urban drainage systems and urban water supply/distribution systems at the catchment level. Hydrologic, hydraulic, and statistical modelling tools used in industry will be used to evaluate the performance of water resources systems. Topics will include: the urban water cycle, environmental considerations in master planning of drainage and water supply systems, climate change impacts on water resources systems, floodplain analysis and flood control, statistical analysis of rainfall and stochastic hydrology, continuous simulation modelling, planning and modelling of large-scale urban drainage systems, planning and modelling of large-scale water distribution systems, reliability analysis and water quality analysis of water distribution systems, and the master planning process for urban drainage and drinking water systems.
NOT OFFERED 2024-2025
(Lec: 3, Lab: 0, Tut: 1)
Requirements: Prerequisites: CIVL 350 Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 12
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 12
Offering Faculty: Smith Engineering
Course Learning Outcomes:

1. Use industry-standard models to simulate the performance of large-scale water resources systems in urban catchments.
2. Apply probability theory and statistical tools to solve water resources problems.
3. Apply the governing equations of open channel flow and closed-conduit flow to make predictions about hydraulic quantities.
4. Design a large-scale water resource system.

CIVL 490 Selected Topics in Civil Engineering Units: 4.00
Providing advanced study and application of selected topics in Civil Engineering, this course will be offered periodically by visiting faculty and professionals. Consult the department homepage for opportunities.
NOT OFFERED 2024-2025
(Lec: 3, Lab: 0, Tut: 1)
Requirements: Prerequisites: Successful completion of 3rd year Civil Engineering and permission of the Department. Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 32
Engineering Design 16
Offering Faculty: Smith Engineering
Course Learning Outcomes:

1. Explain the framework and key considerations of transportation planning.
2. Apply the planning and decision-making process of Environmental Assessment (Act).
3. Describe the key components of Active Transportation and Complete Streets.
4. Explain the fundamentals of Road Safety and Human Factors.
5. Discuss the elements of roadway geometric design.
6. Propose solutions to a corridor improvement problem.
7. Apply basic bus transit service design.
8. Review Transportation Demand Management.
9. Identify the trends and future of transportation.
10. Recognize the important roles of transportation engineer in society.

CIVL 491 Selected Topics in Civil Engineering Units: 4.00
Providing advanced study and application of selected topics in Civil Engineering, this course will be offered periodically by visiting faculty and professionals. Consult the department homepage for opportunities.
(Lec: 3, Lab: 0, Tut: 1)
Requirements: Prerequisites: Successful completion of 3rd year Civil Engineering and permission of the Department. Corequisites: Exclusions:
Offering Term: W
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 32
Engineering Design 16
Offering Faculty: Smith Engineering
Course Learning Outcomes:

1. Explain the framework and key considerations of transportation planning.
2. Apply the planning and decision-making process of Environmental Assessment (Act).
3. Describe the key components of Active Transportation and Complete Streets.
4. Explain the fundamentals of Road Safety and Human Factors.
5. Discuss the elements of roadway geometric design standards.
6. Propose solutions to a freeway interchange problem.
7. Analyze traffic signal warrant and calculate design signal timing, traffic flow and roadway level of service.
8. Review Traffic Demand Forecasting and Traffic Management.
9. Identify the trends and future of transportation.
10. Recognize the important roles of transportation engineer in society.

CIVL 492 Transportation Planning and Engineering Units: 4.00
An introductory course providing students with the principles of transportation planning and engineering and a comprehensive overview, definitions, concepts, characteristics of the various land modes/components/ systems of transportation. Topics include: transportation system; transportation planning framework; bicycles and pedestrians; traffic safety & human factors; roadway geometric design; traffic flow and capacity; level of service; highway classification; transportation in a changing world; automated vehicles and Ontario Environmental Assessment. 'Big picture' discussions on the social, economic, political and environmental roles of transportation as well as the various roles and career paths for transportation engineers are also included. The course offers real-world case studies and best practices in transportation. You will learn and apply critical thinking in solving solutions without equations and formulae. This single course in transportation provides for a solid grounding in transportation engineering opportunities for related professional employment and continuing academic pursuit.
(Lec: 3, Lab: 0, Tut: 1)
Requirements: Prerequisites: Current Civil Engineering 4th Year students, or permission of the instructor. Corequisites: Exclusions:
Offering Term: F
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 32
Engineering Design 16
Offering Faculty: Smith Engineering
Course Learning Outcomes:

1. CLOs coming soon; please refer to your course syllabus in the meantime.

CIVL 500 Civil Engineering Thesis Units: 4.00
Working closely with a faculty member, students will conduct research on a civil engineering or related applied science topic. Students will: identify a problem; formulate a research question; and devise and implement a research plan. The nature of the research may involve obtaining experimental measurements, performing field testing and/or numerical analysis, and analyzing and interpreting research results. Students will prepare a comprehensive, written technical report and will defend their research in an oral examination. Registration is limited to a maximum of twenty (20) students PPE will be required for this course at student's cost (see course materials for details).
K4(Lec: Yes, Lab: Yes, Tut: Yes)
Requirements: Prerequisites: successful completion of 3rd year civil engineering with a minimum sessional average of 70% Corequisites: Exclusions:
Offering Term: FW
CEAB Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 24
Engineering Science 24
Engineering Design 0
Offering Faculty: Smith Engineering
Course Learning Outcomes:

1. Analyze and interpret literature and identify research needs.
2. Contribute to the advancement of knowledge, developing new data and synthesize research information considering sources of uncertainty and limitations to reach substantiated conclusions.
3. Effectively plan their project, including mitigating risks, to complete the project on-time.
4. Deliver formal oral presentations with suitable language, content, style, timing and flow, adapted to context.
5. Produce clear, concise, precise and well-organized written communication, with figures and references.