MAÎTRISE ÈS SCIENCES APPLIQUÉES GÉNIE CIVIL CONCENTRATION INFRASTRUCTURE DURABLE ET RÉSILIENTE

Survol

Les infrastructures de génie civil constituent l'épine dorsale de la société. Les ingénieurs civils conçoivent les infrastructures constituant les centres urbains, y compris les bâtiments, les ponts, les routes et autres réseaux de transport. Les infrastructures hydrauliques telles que les réseaux de canaux et de canalisations, les usines de traitement des eaux et des eaux usées et les installations de gestion des déchets. Les ingénieurs civils sont chargés de veiller à ce que cette infrastructure résiste aux risques naturels et anthropiques, notamment les inondations, les tremblements de terre et les attaques terroristes. Compte tenu des changements climatiques et de la géopolitique récentes, le risque imposé par de tels aléas augmente, d'où la nécessité de renforcer les infrastructures et d'en accroître la capacité. En même temps, la construction, l'exploitation et la maintenance de ces infrastructures consomment d'énormes quantités de ressources naturelles et d'énergie, et l'expansion industrielle de l'urbanité à travers la planète a dégradé la biosphère et modifé l'atmosphère. La durabilité de la société dépend de solutions innovantes de conception d'infrastructures qui minimisent l'utilisation des ressources et de l'énergie. Une infrastructure plus résiliente peut avoir une durée de vie plus longue, ce qui améliore la durabilité, mais peut également consommer plus de ressources. La conception d'infrastructures résilientes mais durables est un défi existentiel pour les ingénieurs civils.

Il existe un besoin et une demande pour un personnel en génie civil hautement qualifié, capable de prendre en compte la durabilité et la résilience lors de la conception d'une infrastructure. Cependant, les formations classiques en génie civil ne tiennent pas compte simultanément de la durabilité et de la résilience. Cette concentration en infrastructure durable et résiliente répond à ce besoin.

En bref

- Grade universitaire offert : Maîtrise ès sciences appliquées (M.Sc.A)
- Options de statut d'inscription : Temps complet ou Temps partiel
- Langue d'enseignement : Anglais
- Option d'étude (durée prévue du programme) :
  - dans une période de 2 ans à temps complet
- Unités scolaires : Faculté de génie (https://genie.uottawa.ca/), département de génie civil (https://genie.uottawa.ca/dept-civil/), Institut de génie civil d'Ottawa-Carleton (http://www.ocice.ca/) (disponible en anglais seulement)

Description du programme

Ce programme répond aux exigences du programme général de maîtrise en génie civil, mais fournit une concentration en infrastructure durable et résiliente en prenant au moins 12 unités de cours dans le domaine. Il est essentiel que les ingénieurs civils comprennent comment développer et maintenir en toute sécurité et de manière responsable une infrastructure durable et résiliente.

Principaux domaines de recherche

- Génie environnemental
- Génie géotechnique
- Génie des structures
- Génie des ressources hydriques
- Ingénierie et gestion de la construction
- Matériaux et constructions durables

Autres programmes offerts dans la même discipline ou dans une discipline connexe

- Maîtrise ès sciences appliquées Génie civil (M.Sc.A)
- Maîtrise ès sciences appliquées Génie de l'environnement (M.Sc.A)
- Maîtrise ès sciences appliquées Génie civil Spécialisation en science, société et politique publique (M.Sc.A)
- Maîtrise ès science appliquées Génie de l'environnement Spécialisation en durabilité de l'environnement (M.Sc.A)
- Maîtrise en ingénierie Génie civil (M.Ing.)
- Maîtrise en ingénierie Génie de l'environnement (M.Ing.)
- Doctorat en philosophie Génie civil (Ph.D.)
- Doctorat en philosophie de l'environnement

Coût et financement

- Frais reliés aux études
  - Le montant estimé des droits universitaires (https://www.uottawa.ca/droits-universitaires/) de ce programme est disponible sous la section Financier vos études (http://www.uottawa.ca/etudes-superieures/programmes-admission/financer-etudes/).
  - Les étudiants internationaux inscrits à un programme d'études en français peuvent bénéficier d'une exonération partielle des droits de scolarité (https://www.uottawa.ca/droits-universitaires/exoneration-partielle-des-droits-de-scolarite/).
- Pour des renseignements sur les moyens de financer vos études supérieures, veuillez consulter la section Bourses et appui financier (https://www.uottawa.ca/etudes-superieures/etudiants/bourses/).

Notes

- Les admissions sont régies par les règlements généraux en vigueur pour les études supérieures de l'Université d'Ottawa.
- Conformément au règlement de l'Université d'Ottawa, les étudiants ont le droit de rédiger leurs travaux, leur thèse et de répondre aux questions d'examen en français ou en anglais.
- Les activités de recherche peuvent se dérouler soit en anglais, soit en français, soit dans les deux langues selon les compétences linguistiques des professeurs et des membres du groupe de recherche concernés.

Coordonnées du programme

Bureau des études supérieures, Faculté de génie (https://genie.uottawa.ca/bureau-des-etudes-superieures/)
STE 1024
800 King Edward Ave.
Ottawa ON Canada

K1N 6N5

Tél. : 613-562-5347
Téléc. : 613-562-5129
Courriel : etudesup.genie@uottawa.ca

Twitter | Faculté de génie (https://twitter.com/uottawagenie/)
Facebook | Faculté de génie (https://www.facebook.com/uottawa.engineering/)

Exigences d'admission

Pour connaître les renseignements à jour concernant les dates limites, les tests de langues et autres exigences d'admission consultez la page des exigences particulières (https://www.uottawa.ca/etudes-superieures/programmes-admission/admission/exigences-particulieres/).

Pour être admissible, vous devez:

- Être titulaire d'un baccalauréat spécialisé (ou avec majeure) en génie civil ou autres disciplines connexes, considérées comme étant du domaine du génie civil, avec une moyenne minimale de B+ (75%);
  - Note: Les candidats internationaux doivent vérifier les équivalences d'admissions (https://www.uottawa.ca/etudes-superieures/international/etudier-uottawa/equivalences-admission/) pour le dîplome obtenu dans leur pays de provenance.
- Les demandes d'admission à un programme de propédeutique émanant de candidats diplômés d'autres programmes de génie ou de programmes de baccalauréat avec spécialisation en sciences, seront sujettes aux condition suivantes:
- Les candidats qui détiennent un diplôme en génie ou qui ont terminé un programme avec spécialisation en sciences incluant un contenu an mathématiques équivalant au programme de génie civil devront suivre au moins quatre cours de premier cycle en génie civil dans leur domaine de spécialité au deuxième cycle en vue de se qualifier.
- Les candidats provenant d'autres programmes de sciences devront suivre tous les cours obligatoires de mathématiques du programme de premier cycle en génie civil en plus de satisfaire aux conditions énoncées ci-desus. Les cours de premier cycle exigés figureront au certificat d'admission.
- Démontrer une bonne aptitude à la recherche que ce soit dans le contexte d'un projet de quatrième année au baccalauréat ou par la rédaction de rapports de recherche, de résumés ou d'autres documents démontrant des habiletés de recherche.
- Identifier au moins un professeur prêt à diriger votre recherche et votre thèse.
  - Il est recommandé de communiquer avec le directeur de thèse dès que possible.
  - Pour pouvoir vous inscrire, vous devez faire accepter votre candidature par un directeur de thèse.
  - Le nom du professeur est requis lors de la demande d'admission.

Le cheminement accéléré a deux exigences additionnelles :

- Compléter CVG 4907 Projet de conception en génie civil et jusqu'à 3 (mais pas moins de deux) cours de maîtrise en génie civil chacun avec une note de 70% (B) ou plus (au cours de leur programme de baccalauréat en génie civil).
- Dois être en train de compléter ou avoir complété un diplôme de premier cycle en génie civil à l'Université d'Ottawa et idéalement avoir déjà commencé une recherche pertinente aux études supérieures au cours de la quatrième année d'études.

Exigences linguistiques

Les cours sont offerts en anglais, langue internationale de technologies de pointe en ingénieirie. Le programme fournira un environnement propice aux étudiants fancophones afin qu'ils développent des compétences professionnelles en anglais technique à leur propre rythme. Toutefois, les étudiants ont le droit, conformément aux règles de l'Université en matière de bilinguisme (règlement académique I-2), de faire tous leurs travaux, y compris leur thèse, dans la langue officielle de leur choix (français ou anglais). Il y a des professeurs et des conseillers entièrement bilingues qui peuvent appuyer les étudiants en français.

Ceux dont la langue maternelle n'est ni le français ni l'anglais doivent fournir une preuve de compétence dans la langue d'enseignement.

Note : Les coûts des tests de compétences linguistiques devront être assumés par le candidat.

Notes

- Les conditions d'admission décrites ce-dessus représentent des exigences minimales et ne garantissent pas l'admission au programme.
- L'admission aux programmes d'études supérieures en génie civil est régie par les règlements généraux (http://www.uottawa.ca/etudes-superieures/etudiants/reglements-generaux/) en vigueur pour les études supérieures et les règlements généraux de l'Institut de génie civil d'Ottawa-Carleton (IGCOC).
- Les cours de premier cycle en génie civil ne seront pas crédités au programme d'études supérieures. Des cours de premier cycle peuvent malgré tout être exigés en vue de satisfaire aux conditions d'admission.

Exigences du programme Maîtrise avec thèse

Les exigences à remplir sont les suivantes :

Cours obligatoires :		
CVG 5214	Sustainable and Resilient Infrastructure	3 crédits
9 crédits de cours optionnels parmi la liste de cours optionnels [1]		
3 crédits de cours optionnels en génie civil (CVG) ou génie environnemental (EVG) de niveau gradué [1]		
Séminaire :		
CVG 5366	Master's Seminar in Civil Engineering	
Thèse :		
THM 7999	Thèse de maîtrise [2]	

Note(s)

1

Parmi les 12 crédits de cours optionnels, 9 crédits doivent provenir d'une liste de cours optionnels approuvés par le programme et doivent provenir d'au moins deux des groupes suivants : Durabilité, Résilience et Durablilité et résilience.

2

L'étudiant est responsable de s'assurer de rencontrer les exigences relatives à la thèse (https://www.uottawa.ca/etudes-superieures/etudiants/theses/). La thèse doit être basée sur des travaux de recherche originaux effectués sous la direction immédiate d'un membre du corps professoral du département et doit relever du domaine des infrastructures durables et résilientes.

Maîtrise avec thèse, cheminement accéléré

Les exigences à remplir sont les suivantes :

Cours obligatoires :		
CVG 5214	Sustainable and Resilient Infrastructure	3 crédits
6 crédits de cours optionnels en génie civil (CVG) ou génie de l'environnement de niveau gradué [1]		6 crédits
Séminaire :		
CVG 5366	Master's Seminar in Civil Engineering	
Thèse :		
THM 7999	Thèse de maîtrise [2]	

Note(s)

1

Si 9 crédits de cours de la maîtrise en génie civil ont été complétés durant les études de premier cycle, seulement 6 crédits de cours obligatoires en génie civil (CVG) ou génie de l'environnement (EVG) de niveau gradué seront requis pour satisfaire l'exigence des cours obligatoires.
Les cours optionnels doivent provenir d'une liste de cours optionnels approuvés par le programme et doivent provenir d'au moins deux des groupes suivants : Durabilité, Résilience et Durablilité et résilience.

2

L'étudiant est responsable de s'assurer de rencontrer les exigences relatives à la thèse (https://www.uottawa.ca/etudes-superieures/etudiants/theses/). La thèse doit être basée sur des travaux de recherche originaux effectués sous la direction immédiate d'un membre du corps professoral du département et doit relever du domaine des infrastructures durables et résilientes.

Liste de cours optionnels

Durabilité		
CVG 5150	Advanced Concrete Technology	3 crédits
CVG 5181	Decentralized Wastewater Management	3 crédits
CVG 5183	Mixing and Transport of Pollutants in Water Bodies	3 crédits
CVG 5301	Soil and Water Conservation Engineering	3 crédits
EVG 5133	Solid Waste Management	3 crédits
EVG 5139	Environmental Assessment of Civil Engineering Projects	3 crédits
Résilience		
CVG 5144	Advanced Reinforced Concrete	3 crédits
CVG 5151	Advanced Timber Design	3 crédits
CVG 5155	Earthquake Engineering	3 crédits
CVG 5188	Loads on Structures	3 crédits
CVG 5189	Blast Engineering	3 crédits
CVG 5190	Rehabilitation of Concrete Structures	3 crédits
Durabilité et résilience		
CVG 5182	Water Resources Management	3 crédits
CVG 5191	Diagnosis and Prognosis of Concrete Infrastructure	3 crédits
CVG 5212	Climate Change Impacts on Water Resources	3 crédits
CVG 5216	Sustainable and Resilient Infrastructure in Changing Climate	3 crédits
CVG 5314	Geotechnical Hazards	3 crédits

Exigences minimales

La note de passage dans tous les cours est B.

Les étudiants qui échouent 6 crédits doivent se retirer du programme.

Passage accéléré de la maîtrise au doctorat

Les étudiants inscrits au programme de maîtrise en génie civil à l'Université d'Ottawa ont la possibilité de passer directement au programme de doctorat sans avoir à rédiger la thèse de maîtrise. Pour de plus amples renseignements, veuillez consulter la section "Exigences d'admission" du programme de doctorat.

Recherche
Domaines de recherche et installations

Située au coeur de la capitale du Canada, à quelques pas de la colline du Parlement, l'Université d'Ottawa est l'une des 10 principales universités de recherche au Canada.

uOttawa concentre ses forces et ses efforts dans quatre axes prioritaires de développement de la recherche :

- Le Canada et le monde
- La santé
- La cybersociété
- Les sciences moléculaires et environnementales

Grâce à leurs recherches de pointe, nos étudiants diplômés, nos chercheurs et professeurs exercent une forte influence sur les priorités à l'échelle nationale et internationale.

La recherche à la Faculté de génie

Principaux domaines de recherche :

- Génie chimique et biologique
- Génie civil
- Science informatique et génie électrique
- Génie mécanique

Pour d'autres informations. veuillez consulter la liste des membres du corps professoral et leurs domaines de recherche sur Uniweb (https://uniweb.uottawa.ca/#!/themes/0/people).

IMPORTANT : Les candidats et les étudiants à la recherche de professeurs pour superviser leur thèse our leur projet de recherche peuvent aussi consulter le site Web de la faculté ou du département **(**https://www.uottawa.ca/etudes-superieures/students/academic-unit-contact-information/**) du programme de leur choix. La plateforme Uniweb**

n'est pas représentative de l'ensemble du corps professoral autorisé à diriger des projets de recherche à l'Université d'Ottawa.

Cours

CVG 5100 Deep Foundations (3 units)
Deep foundation types in North American practice (driven or bored piles, and slurry trench techniques); axial and lateral capacity and settlement analysis for single piles and pile groups; field inspection methods; pile dynamics; performance and analysis of static test loading. This course is equivalent to CIVJ 5000 at Carleton University.
Course Component: Lecture

CVG 5106 Site Improvements (3 units)
Description, design procedures and usage of current site improvement techniques, including preloading, earth reinforcement, dynamic consolidation, vibrocompaction, blasting densification, lime treatment, drains, and geotechnical fabrics. This course is equivalent to CIVJ 5006 at Carleton University.
Course Component: Lecture

CVG 5111 Hydraulic Structures (3 units)
Classification and function of hydraulic structures; analysis and design of hydraulic works for gravity dams, arch dams, earth fill and rock-fill dams; ancillary works including water intakes, various types of spillways, control structures, energy dissipation and stilling basin, bottom outlets. Advanced topic in channel design including transitions; hydraulic transients, free surface and free surge analysis; water towers and compensation basins; penstocks. Navigation locks. Coastal protection works and maritime structures. This course is equivalent to CIVJ 5501 at Carleton University.
Course Component: Lecture

CVG 5112 Computational Hydrodynamics (3 units)
Finite volume methods for advection, diffusion and shallow water equations using structured and unstructured grids, finite volume methods for incompressible Navier-Stokes equations (SIMPLE, SIMPLEC, PISO), error analysis: numerical diffusion and dispersion, truncation errors and Fourier analysis, introduction to turbulence modeling, introduction to methods for tracking free surfaces and moving beds, introduction to other methods in hydrodynamics: finite element, finite difference, Chebyshev and Fourier spectra, semi Lagrangian and vortex methods inhydrodynamics. This course is equivalent to CIVJ 5502 at Carleton University.
Course Component: Lecture

CVG 5120 Water Resources Systems (3 units)
Conservation of water resources. Multi-purpose project planning: study of domestic and foreign water development projects. Techniques for simulation, optimization, linear and dynamic programming. This course is equivalent to CIVJ 5506 at Carleton University.
Course Component: Lecture

CVG 5123 Advanced Topics in Hydrology (3 units)
Selected topics of current interest in surface and groundwater hydrology. This course is equivalent to CIVJ 5509 at Carleton University.
Course Component: Lecture

CVG 5124 Coastal Engineering (3 units)
Key concepts in coastal engineering: (1) wave mechanics and coastal hydrodynamics, (2) sediment transport and coastal morphodynamics and (3) coastal structures and coastal zone management. Wave mechanics and coastal hydrodynamics to include small-amplitude wave theory, finite amplitude wave theories (Stokes, Cnoidal and solitary wave), wave generation, wave transformations, development and prediction, hydrodynamics of coastal circulation. Sediment transport and coastal morphodynamics to include: wave and current-induced sediment transport, coastal sediment processes, longshore and cross-shore beach morphologic transformations, etc. Coastal structures and coastal zone management to include: beach erosion control, coastal structures (dikes, breakwaters, groins, seawalls), beach nourishment, coastal pollution and control, nearshore area development. This course is equivalent to CIVJ 5605 at Carleton University.
Course Component: Lecture

CVG 5125 Statistical Methods Hydrology (3 units)
Concepts of probability and random variables applied to hydrology. Statistical distributions, their approximation and analysis. Statistical inference, including tests of significance and estimation theory. Linear and multivariate correlation and regression techniques. Data generation and simulation techniques for design of water-resource systems. Introduction to hydrologic and meteorologic time series. This course is equivalent to CIVJ 5601 at Carleton University.
Course Component: Lecture

CVG 5142 Advanced Structural Dynamics (3 units)
Dynamic behaviour of civil engineering structures under excitations due to earthquakes, wind, waves, etc. Advanced methods in dynamic analysis of structures. Prediction of structural response. Design considerations. This course is equivalent to CIVJ 5201 at Carleton University.
Course Component: Lecture

CVG 5143 Advanced Structural Steel Design (3 units)
Analysis of thin-walled beams; design applications including members under combined forces; analysis and design of beams under non-uniform torsion; limit state design methodology; comparative study of modern structural steel standards; formulating elastic and plastic interaction relations for members under combined forces; designing columns, beams, and beam columns for cross-sectional strengths; local buckling and global stability considerations; design of bracing systems. This course is equivalent to CIVJ 5202 at Carleton University.
Course Component: Lecture

CVG 5144 Advanced Reinforced Concrete (3 units)
Study of the elastic and inelastic response of reinforced concrete structures under monotonic and cyclic loading. Methods for predicting structural behaviour of concrete elements. The relationship between recent research results and building codes. This course is equivalent to CIVJ 5300 at Carleton University.
Course Component: Lecture

CVG 5145 Theory of Elasticity (3 units)
Stress-strain relations. Theories of plane stress and plane strain. Use of stress functions, energy and variational methods in the analysis of elastostatic problems. This course is equivalent to CIVJ 5203 at Carleton University.
Course Component: Lecture

CVG 5146 Numerical Methods of Structural Analysis (3 units)
Numerical procedures and methods of successive approximations for the solution of structural problems. Virtual work, principles of minimum potential and complementary energy. Applications of variation and finite difference techniques to the solutions of complicated problems in beams, plates and shells. This course is equivalent to CIVJ 5302 at Carleton University.
Course Component: Lecture

CVG 5147 Theory of Plates and Shells (3 units)
Stress distribution in flat plates of various shapes. Large deflection theory, numerical methods. Membrane theory, bending theory for cylindrical shells, bending theory for shells of revolution. This course is equivalent to CIVJ 5204 at Carleton University.
Course Component: Lecture

CVG 5148 Prestressed Concrete Design (3 units)
Materials, methods of prestressing, prestress losses, and anchorage zone stresses. Elastic analysis, design and behaviour of simple and continuous prestressed concrete beams, frames and slabs. Discussion of current design specifications. Ultimate strength of members. This course is equivalent to CIVJ 5305 at Carleton University.
Course Component: Lecture

CVG 5149 Structural Stability (3 units)
Elastic, inelastic, and torsional buckling of columns, beam column behaviour, plane and space frame stability, lateral torsional buckling of beams, global buckling of truss systems, plate and shell buckling, local buckling in tubulars, use of energy methods, matrix analysis, and finite element analysis in modeling stability problems, bracing requirements, standard provisions and design considerations in structural stability. This course is equivalent to CIVJ 5304 at Carleton University.
Course Component: Lecture

CVG 5150 Advanced Concrete Technology (3 units)
Cement: types, hydration, physical properties; aggregate: classification, grading, properties; fresh concrete: influence of basis constituents and admixtures on workability, mixing, placing; strength of hardened concrete; nature of strength, influence of constituents, curing methods; durability; chemical attack, frost action, thermal effects; elasticity, shrinkage and creep; special concrete; lightweight, high density; mix design; approaches, weigh batching, volume proportioning, special mixes; field and laboratory test methods. This course is equivalent to CIVJ 5206 at Carleton University.
Course Component: Lecture

CVG 5151 Advanced Timber Design (3 units)
Characteristic values for timber and engineered wood products , modification factors used in design; design of members subjected to combined bending axial loading; design for bi-axial bending; design of curved glued laminated beams, Timber-Concrete Composite (TCC) floor systems; lateral design (wind and seismic loading) for light-frame, CLT and hybrid structures; advanced connection design including design of proprietary connections.
Course Component: Lecture

CVG 5153 Wind Engineering (3 units)
The structure and climate of wind; wind loading on structures; wind induced dynamic problems of structures; environmental aerodynamics; dispersion of pollutant; analysis of wind data; experimental investigations. This course is equivalent to CIVJ 5209 at Carleton University.
Course Component: Lecture

CVG 5154 Random Vibration (3 units)
Descriptions of random data. Frequency domain analysis and time domain analysis. Stochastic response of structures; wind and earthquake excitation, etc. Data analysis techniques. Prediction for design purposes. Simulation of random processes. Special topics. This course is equivalent to CIVJ 5308 at Carleton University.
Course Component: Lecture

CVG 5155 Earthquake Engineering (3 units)
Nature and characteristics of earthquake motions. Non-linear response of single and multi-degree-of-freedom structures to seismic excitations. Modal superposition technique. Simplified procedures for dynamic structural analysis. Principles of earthquake resistant design. Strength, stiffness, ductility and energy absorption requirements of structures for seismic forces. Response spectra analysis. Current design procedures for aseismic design. Recent research on earthquake engineering. This course is equivalent to CIVJ 5306 at Carleton University.
Course Component: Lecture

CVG 5156 Finite Element Methods (3 units)
Review of basic matrix methods. Structural idealizations. The displacement versus the force method. Stiffness properties of structural elements. Finite elements in beam bending, plane stress and plate bending. This course is equivalent to CIVJ 5301 at Carleton University.
Course Component: Lecture

CVG 5157 Finite Element Methods (3 units)
Application of finite elements to folded plates, shells and continua. Convergence criteria and order of accuracy. Inertial and initial stress properties. Dynamic and buckling problems. Non-linear deflections and plasticity. This course is equivalent to CIVJ 5303 at Carleton University.
Course Component: Lecture

CVG 5158 Elements of Bridge Engineering (3 units)
Introduction; limit state design; highway bridge design loads; analysis and design of concrete decks; impact and dynamics; load capacity rating of existing bridges and construction in cold climate. This course is equivalent to CIVJ 5307 at Carleton University.
Course Component: Lecture

CVG 5159 Long Span Structures (3 units)
Mechanics of cables. Suspension bridges and cable-stayed bridges. Space structures. Design and construction of long span structures. Dynamics of long span bridges. Case studies. Future of long span structures. This course is equivalent to CIVJ 5309 at Carleton University.
Course Component: Lecture

CVG 5160 Sediment Transport (3 units)
An introduction to particle transport, with special emphasis on river engineering applications, including natural channel design. Sediment properties, initiation of motion, bed load, suspended load, fluvial dunes, alluvial channels, bank erosion and protection, natural channel design. Special topics include contaminated sediments, local scour, morphodynamic modelling, fluvial habitat. This course is equivalent to CIVJ 5503 at Carleton University.
Course Component: Lecture

CVG 5161 Mechanics of Unsaturated Soils (3 units)
Introduction to unsaturated soils, phases of an unsaturated soil, phase properties and relations, stress state variables for saturated and unsaturated soils. Measurement of soil suction: theory of soil suction, capillarity, measurements of total suction and matric suction. Flow Laws: flow of water and measurement of permeability, shear strength theory: history, failure envelope for unsaturated soils, triaxial and direct shear tests, typical results, simple testing procedures, volume change behavior including expansive soils behavior. Soil-water characteristic curve: its behavior and use in predicting the engineering properties of unsaturated soils, practical applications of the principles of unsaturated soils. This course is equivalent to CIVJ 5106 at Carleton University.
Course Component: Lecture

CVG 5162 River Hydraulics (3 units)
Advanced concepts of river hydraulics, with an emphasis on field measurement techniques and application of numerical models. Navier-Stokes equations, turbulence, flow resistance, numerical modelling of simplified momentum and continuity equations, field-based measurement and statistical analysis of velocity fields. Special topics include contaminant transport, morphodynamic modelling. This course is equivalent to CIVJ 5504 at Carleton University.
Course Component: Lecture

CVG 5175 Numerical Methods for Geotechnical Engineers (3 units)
Non-linear analysis of stresses and deformations using the effective stress concept; analysis of consolidation using the excess pore water pressure concept; flow through porous media; finite element, discrete element and finite difference methods; applications to foundations of structures, retaining walls, dams, tunnels, pipelines, human-made and natural slopes in rock and soil. This course is equivalent to CIVJ 5105 at Carleton University.
Course Component: Lecture

CVG 5178 Ice Mechanics (3 units)
Ice conditions in the Arctic; ice physics; classification of ice; mechanical properties of ice; mathematical modelling of creep and fracture behaviour of ice; offshore structures in arctic environments; ice forces acting on structures; ice induced vibrations; iceberg impact loads; physical modelling of ice-structure interaction; ice as a construction material; case histories. This course is equivalent to CIVJ 5108 at Carleton University.
Course Component: Lecture

CVG 5180 Biological Nutrient Removal (3 units)
Advanced theoretical, biological, and practical aspects of biological nutrient removal (BNR) (nitrification, denitrification and excess biological phosphorus) processes. Principles to be applied to the design and application of conventional and advanced BNR processes used for treatment of municipal and industrial wastewaters. Topics are as follows: microbiology and biochemistry fundamentals of BNR, nitrification process design of suspended growth and fixed film growth systems, denitrification process design of suspended growth and fixed film growth systems, excess biological phosphorus removal design including prefermentation. Design of 2, 3, 4 and 5 stage BNR systems. General activated sludge model and Simworks for BNR systems. Retrofit of exiting plants and pilot plant testing for BNR. This course is equivalent to ENVJ 5909 at Carleton University.
Course Component: Lecture

CVG 5181 Decentralized Wastewater Management (3 units)
Fundamental principles and practical design applications of decentralized wastewater treatment for domestic and industrial sources. Management of decentralized wastewater systems; Pre-treatment systems; Soil infiltration systems; Advanced onsite technologies, constructed wetlands; Alternative collection systems; Wastewater reuse and septage management.
Course Component: Lecture

CVG 5182 Water Resources Management (3 units)
Global water supply and demand; Integrated water resources management; Modeling and optimization of water resources systems; Reservoir Management; Uncertainty modeling; Climate Change and water; Decision under uncertainty.
Course Component: Lecture

CVG 5183 Mixing and Transport of Pollutants in Water Bodies (3 units)
Typical models for selected water resources systems : Rivers, lakes, estuaries; Water quality parameters; Conservative parameters; Non conservative parameters; Laminar and turbulent flows; Dispersion; Pollution sources; Modeling; Simplified (integral) models; Dilution models; Three Dimensional models; Advection-Diffusion Equation; Analytical solution; Numerical solution; Non-conservative transport and Multi-component systems; Modeling approaches based on conservative and non-conservative transport and kinetics; Certain water quality parameters (Temperature, Salinity, etc.).
Course Component: Lecture

CVG 5184 Construction Cost Estimating (3 units)
General overview of construction cost estimating. Techniques and construction cost estimating process; Elements of project cost; Conceptual and detailed cost estimation methods; Risk assessment and range estimating; Work breakdown structure applied in building projects. Computer applications in building construction cost estimating and infrastructure projects.
Course Component: Lecture

CVG 5185 Construction Life Cycle Analysis (3 units)
General overview of analyzing the economics of construction projects by applying the concept of time value of money. Financing strategies for construction projects and profitability analysis; Correlation between Value Engineering, Life cycle cost analysis and assessment for construction projects. Break Even, Sensitivity and Risk analysis and their application to project life cycle analysis.
Course Component: Lecture

CVG 5186 Project Information Management (3 units)
Topics in contractual relationships between construction project teams. Different type of construction contracts and their application. Preparation of project documents. Evaluation of different types of project organization structure and associated project delivery systems. Bidding strategies. Network analysis using deterministic and stochastic methods for construction time and cost management.
Course Component: Lecture

CVG 5187 Rock Mechanics (3 units)
Rock exploration, laboratory and in-situ testing; rock mass classification; deformation and strength; failure criteria; stresses in rock; foundations on rock.
Course Component: Lecture

CVG 5188 Loads on Structures (3 units)
Overview of loads on buildings according to Canadian codes and standards. Dead and live loads; Snow loads; Wind loads; Earthquake loads; Loads on non-structural components; Vibrations. Selected topics in the practical design of building structures.
Course Component: Lecture

CVG 5189 Blast Engineering (3 units)
Overview of explosives and blast loads on structural and non-structural infrastructure components; dynamic analysis of elements under blast-induced shock waves and dynamic pressures; elastic and inelastic response; incremental equation of motion and nonlinear analysis; development of resistance functions; pressure-impulse (P-I) diagrams; design of blast-resistant buildings and building components, including glazed windows, curtain walls, and blast-resistant doors as per codes and standards; progressive collapse analysis; blast retrofits and blast-risk mitigation strategies.
Course Component: Lecture

CVG 5190 Rehabilitation of Concrete Structures (3 units)
Durability of concrete bridges and building structures in Canada; assessment and evaluation of damaged concrete structures; repair, rehabilitation, and strengthening techniques; applicable design codes and guidelines; monitoring technologies for structures; implications for infrastructure management.
Course Component: Lecture

CVG 5191 Diagnosis and Prognosis of Concrete Infrastructure (3 units)
Condition assessment of concrete infrastructure using experimental (i.e. visual, non-destructive, microscopic and mechanical) and analytical approaches; Overview of repair and maintenance techniques according to damage type and extent; “Serviceability performance” and “appraisal guides” for aging infrastructure; Design for durability through performance based design (PBD) approaches.
Course Component: Lecture

CVG 5192 Characterization Methods for Materials (3 units)
Modern materials characterization techniques especially with respect to civil engineering materials. Choosing the right characterization methods in order to determine the properties of materials such as chemical composition, atomic structure, and surface properties used in their research. Interpreting the results of each method as well as the insight into the interrelationships between characterization methods and their interdependency.
Course Component: Lecture

CVG 5193 Instrumentation and Experimental Design for Civil Engineering (3 units)
Introduction to instrumentation in civil engineering applications; Instrument types and performance; Strain gauges; Transducers; Measurement of position, velocity, acceleration, force, pressure, temperature and flow; Data collection and data acquisition systems; Diagnostics and calibration; Control (Closed versus Open-loop); Servomotor types and servo-valves.
Course Component: Lecture

CVG 5212 Climate Change Impacts on Water Resources (3 units)
Spatiotemporal distribution of water and its impact on human activities, including domestic and municipal consumption, hydropower generation, rain-fed and irrigated agriculture, design and operation of sewer systems, floodplain zoning, navigation, etc. Critical assessment of methodologies for climate change impacts estimation. Theoretical knowledge and hands-on applications experience needed to perform climate change analysis on a water resources system.
Course Component: Lecture

CVG 5214 Sustainable and Resilient Infrastructure (3 units)
Concepts of sustainability and resiliency as applied to civil engineering infrastructure. Discussion of evolving infrastructure needs and infrastructure risk profiles due to climate and societal change. Introduction to sustainability and resiliency assessment tools including non-stationary risk assessment, triple bottom line accounting, life cycle costs, and carbon accounting. Development of infrastructure design strategies to meet objectives for both sustainability and resiliency.
Course Component: Lecture

CVG 5216 Sustainable and Resilient Infrastructure in Changing Climate (3 units)
Development of a class of infrastructure with long-term sustainability and resiliency under various extreme events, particularly, the events introduced by changing climate. Climate change drivers, climate modelling and climate change impact studies. The concepts of sustainability, resiliency, and reliability. Climatic and flooding hazards. Uncertainty and non-stationarity processes as extreme events become more severe. Benefits of building sustainable and resilient infrastructures in terms of efficient capital and operational costs while providing society with healthier and more convenient infrastructure.
Course Component: Lecture

CVG 5232 Unit Operations of Water Treatment Lab (1.5 unit)
Bench-scale and pilot-scale experiments required to: a) assess the suitability of different physicochemical processes for particular applications, and b) design a full-scale facility. Conventional analytical techniques used in water treatment (pH, alkalinity, hardness, turbidity, color, spectrophotometric analysis). Process analysis techniques for process evaluation and scale-up including: zone sedimentation, batch flux settling tests, coagulation with iron and aluminum salts, flocculent sedimentation, filtration and fluidization, flotation. This course is equivalent to ENVJ 5911 at Carleton University.
Course Component: Lecture
CVG 5132 is corequisite to CVG 5232.

CVG 5238 Advanced Water Treatment Process Lab (1.5 unit)
Bench-scale and pilot-scale experiments required to: a) assess the suitability of different physicochemical processes for the removal of toxic and non-standard contaminants, and b) design a full-scale facility. Tracer tests and non-ideal reactor behaviour, activated carbon adsorption equilibria and kinetics, aeration. Total organic carbon analysis, spectrophotometry. Process analysis, techniques for process evaluation and scale-up including: aeration, analysis of non-ideal flow conditions. Tracer study of three basins, adsorption isotherm tests, activated carbon mini-column tests, oxidation kinetic tests. This course is equivalent to ENVJ 5912 at Carleton University.
Course Component: Lecture
CVG 5138 is corequisite to CVG 5238.

CVG 5301 Soil and Water Conservation Engineering (3 units)
The design, water quality and climate change impacts of soil and water conservation systems. Topics include: urban storm water management (including LID) erosion control practices, subsurface and surface drainage systems and irrigation technologies.
Course Component: Lecture

CVG 5311 Bridge Design (3 units)
Design of highway bridges according to the Canadian Highway Bridge Design Code (CHBDC). Comparisons with other bridge codes (e.g., the American Code - AASHTO, the European, the New Zealand, and the British bridge codes). The topics covered include the following: main structural components of highway bridges; types of highway bridges; serviceability and ultimate limit state design requirements; design loads (dead loads, traffic loads, seismic loads, and wind loads); load combinations; code specifications for loading due to traffic (design lane, characteristics of design truck, positions of design truck on bridge, etc.); dynamic effects due to traffic loads; practical approaches specified in CHBDC for determining forces and deflections in structural embers; principles of capacity design in highway bridges. This course is equivalent to CIVJ 5310 at Carleton University.
Course Component: Lecture

CVG 5312 Durability of Concrete Structures (3 units)
i) Properties of cementitious materials (constituents of concrete; hydration of cement; structure of hardened concrete; transport processes in concrete); ii) deterioration of concrete (built-in problems; construction defects; cracking; dimensional stability; alkali-aggregate reaction; sulphate attack; corrosion of reinforcing steel; freezing-thawing cycles); (iii) evaluation of concrete structures (inspection; in-situ testing; laboratory testing); (iv) repair and maintenance of concrete (repair materials; repair procedures and techniques; prevention, protection and maintenance); and, (v) durability design (philosophy; modelling of deterioration processes; service life prediction; life-cycle cost analysis.) This course is equivalent to CIVJ 5311 at Carleton University.
Course Component: Lecture

CVG 5313 Seismic Analysis and Design of Concrete Structures (3 units)
Review of seismic hazards in Canada, building code provisions for earthquake loads, uniform hazard spectra, linear elastic modal response spectrum analysis, linear elastic time history analysis, equivalent static force procedure, advanced state-of-the-art nonlinear modeling techniques including the finite element method and fiber modeling, emerging methods such as performance-based earthquake engineering and displacement-based design, ductility concepts, plastic hinge formulations, capacity design philosophy for seismic resistance, seismic analysis and design of common seismic force resisting systems including slender and squat shear walls, moment resisting frames, coupled shear walls, and coupling beams, shear wallmoment resisting frame interaction, and lessons learned from recent earthquakes. This course is equivalent to CIVJ 5312 at Carleton University.
Course Component: Lecture

CVG 5314 Geotechnical Hazards (3 units)
Understanding of assessment, prevention, and mitigation of geotechnical hazards, overview of natural and man-made geo-hazards; concepts of hazards, disasters, vulnerability and risks; geotechnical hazards induced by problem soils: fundamentals, assessment, and mitigation; landslide hazards and risk assessment: fundamentals, solutions (prevention, stabilization) for landslides and slope instability; monitoring of landslides and slope; mining geotechnical hazards: hazards related to surface mining geotechnical facilities; hazards related to underground mining geotechnical facilities.
Course Component: Lecture

CVG 5320 Fire Behaviour of Materials (3 units)
Fundamentals and scientific aspects of the behaviour of materials during fires and the fire hazards of materials. Topics to be covered include material specifications, thermal and mechanical properties, structural fire response, residual strength, failure criteria, mechanisms of flame retardancy, and standards and testing protocols. This course is equivalent to CIVE 5615 at Carleton University.
Course Component: Lecture

CVG 5321 Finite Elements in Field Problems (3 units)
Use of Galerkin and Ritz finite element formulation to solve one and two dimensional field problems, steady state and time-dependent phenomena involving potentials, heat transfer, fluid flow, diffusion, and dispersion with emphasis on practical applications. Courses EVG 7402 CVG 5321 cannot be combined for units. This course is equivalent to CIVE 5107 at Carleton University.
Course Component: Lecture
Prerequisite: Basic knowledge of third year-level undergraduate engineering mathematics. Courses EVG 7402, CVG 5321 cannot be combined for units.

CVG 5333 Research Methodology (3 units)
Key components and strategies required to build a robust scientific research program in civil engineering including research questions, literature review, experiment design, data interpretation, scientific manuscripts, public speaking, ethics, and plagiarism.
Course Component: Lecture

CVG 5366 Master's Seminar in Civil Engineering
Attendance and participation in the monthly seminar. All students must make one presentation and continue to attend throughout the program. Graded S (Satisfactory) / NS (Not satisfactory).
Course Component: Seminar

CVG 6000 Projet en génie civil / Civil Engineering Report (6 crédits / 6 units)
Ce cours est équivalent à CIVE 5900 à la Carleton University. / This course is equivalent to CIVE 5900 at Carleton University.
Volet / Course Component: Recherche / Research

CVG 6108 Directed Studies I (3 units)
Special courses set up for one student on an exceptional basis. Limited to one in the Master's level and to two total Master's plus PhD. This course is equivalent to CIVE 5906 at Carleton University.
Course Component: Research
Permission of the Department is required.

CVG 6109 Directed Studies II (3 units)
Special courses set up for one student on an exceptional basis. Limited to one in the Master's level and to two total Master's plus PhD. This course is equivalent to CIVE 5907 at Carleton University.
Course Component: Research
Permission of the Department is required.

CVG 6301 Special Topics in Civil Engineering (3 units)
This course is equivalent to CIVJ 6001 at Carleton University.
Course Component: Lecture

CVG 6303 Special Topics in Civil Engineering (3 units)
This course is equivalent to CIVJ 6003 at Carleton University.
Course Component: Lecture

CVG 6304 Special Topics in Civil Engineering (3 units)
This course is equivalent to CIVJ 6004 at Carleton University.
Course Component: Lecture

CVG 6305 Special Topics in Civil Engineering (3 units)
This course is equivalent to CIVJ 6005 at Carleton University.
Course Component: Lecture

CVG 6306 Special Topics in Civil Engineering (3 units)
This course is equivalent to CIVJ 6006 at Carleton University.
Course Component: Lecture

CVG 6307 Special Topics in Civil Engineering (3 units)
This course is equivalent to CIVJ 6007 at Carleton University.
Course Component: Lecture

CVG 6308 Special Topics in Civil Engineering (3 units)
This course is equivalent to CIVJ 6008 at Carleton University.
Course Component: Lecture

CVG 6309 Special Topics in Civil Engineering (3 units)
This course is equivalent to CIVJ 6009 at Carleton University.
Course Component: Lecture

CVG 6310 Special Topics in Civil Engineering (3 units)
This course is equivalent to CIVJ 6010 at Carleton University.
Course Component: Lecture

CVG 6311 Special Topics in Civil Engineering (3 units)
This course is equivalent to CIVJ 6011 at Carleton University.
Course Component: Lecture

CVG 6312 Special Topics in Civil Engineering (3 units)
This course is equivalent to CIVJ 6012 at Carleton University.
Course Component: Lecture

CVG 6313 Special Topics in Civil Engineering (3 units)
This course is equivalent to CIVJ 6013 at Carleton University.
Course Component: Lecture

CVG 6314 Special Topics in Civil Engineering (3 units)
This course is equivalent to CIVJ 6014 at Carleton University.
Course Component: Lecture

CVG 6315 Special Topics in Civil Engineering (3 units)
This course is equivalent to CIVJ 6015 at Carleton University.
Course Component: Lecture

CVG 6316 Special Topics in Civil Engineering (3 units)
This course is equivalent to CIVJ 6016 at Carleton University.
Course Component: Lecture

CVG 6317 Special Topics in Civil Engineering (3 units)
This course is equivalent to CIVJ 6017 at Carleton University.
Course Component: Lecture

CVG 6318 Special Topics in Civil Engineering (3 units)
This course is equivalent to CIVJ 6018 at Carleton University.
Course Component: Lecture

CVG 6319 Special Topics in Civil Engineering (3 units)
Course Component: Lecture

CVG 6320 Special Topics in Civil Engineering (3 units)
This course is equivalent to CIVJ 6020 at Carleton University.
Course Component: Lecture

CVG 6508 Études dirigées I (3 crédits)
Cours individuels créés seulement pour les cas exceptionnels. Un étudiant peut en suivre un au niveau de la maîtrise ou un total de deux pour les études de maîtrise et de doctorat.
Volet : Cours magistral

CVG 6509 Études dirigées II (3 crédits)
Cours individuels créés seulement pour les cas exceptionnels. Un étudiant peut en suivre un au niveau de la maîtrise ou un total de deux pour les études de maîtrise et de doctorat.
Volet : Cours magistral

CVG 7100 Case Studies in Geotechnical (3 units)
This course is equivalent to CIVE 5209 at Carleton University.
Course Component: Lecture

CVG 7101 Advanced Soil Mechanics I (3 units)
This course is equivalent to CIVE 5300 at Carleton University.
Course Component: Lecture

CVG 7102 Advanced Soil Mechanics II (3 units)
Course Component: Lecture

CVG 7103 Pavement and Materials (3 units)
This course is equivalent to CIVE 5303 at Carleton University.
Course Component: Lecture

CVG 7104 Earth Retaining Structures (3 units)
This course is equivalent to CIVE 5500 at Carleton University.
Course Component: Lecture

CVG 7105 Foundation Engineering (3 units)
This course is equivalent to CIVE 5501 at Carleton University.
Course Component: Lecture

CVG 7106 In Situ Meth in Geomechanics (3 units)
This course is equivalent to CIVE 5502 at Carleton University.
Course Component: Lecture

CVG 7107 Numerical Methods in Geomechanics (3 units)
This course is equivalent to CIVE 5503 at Carleton University.
Course Component: Lecture

CVG 7108 Seepage and Water Flow Through Soils (3 units)
This course is equivalent to CIVE 5504 at Carleton University.
Course Component: Lecture

CVG 7109 Geotechnical Earthquake Engineering (3 units)
This course is equivalent to CIVE 5505 at Carleton University.
Course Component: Lecture

CVG 7110 Road Safety Analysis (3 units)
Fundamental analytical techniques for road safety analysis, background of traffic safety analysis, network screening, before and after analysis, and surrogate measures of safety. This course is equivalent to CIVE 5310 at Carleton University.
Course Component: Lecture

CVG 7111 Advanced Building Characterization, Conservation and Rehabilitation (3 units)
Supporting concepts and techniques for the identification, documentation, and conservation of heritage and existing buildings; advanced workshops by experts from key disciplines and practice areas in heritage conservation. Includes: Experiential Learning Activity. This course is equivalent to CIVE 5603 at Carleton University
Course Component: Laboratory, Lecture

CVG 7112 Wood structures and fire (3 units)
Introduction to fire-safe design of wood buildings, brief review of wood products and wood design, prescriptive code requirements, determination of fire-resistance of wood structures through different methods. Includes: Experiential Learning Activity. This course is equivalent to CIVE 5616 at Carleton University.
Course Component: Laboratory, Lecture

CVG 7113 Practical applications in fire protection (3 units)
Introduction to the practical application of fire protection engineering from a consulting and a regulatory perspective. Main highlights include performance-based design, fire forensics, emergency preparedness and firefighting. This course is equivalent to CIVE 5617 at Carleton University.
Course Component: Lecture

CVG 7114 Probability, Statistics, Stochastic Processes and Statistical Inference in Engineering (3 units)
Fundamental of probability and statistics, (robust and ridge) regression, generalized linear models, sparse models, mixture models, stochastic processes, statistical inference and applications. Includes: Experiential Learning Activity. This course is equivalent to CIVE 5604 at Carleton University.
Course Component: Laboratory, Lecture

CVG 7115 Structural Assessment of Historic Buildings (3 units)
General concepts related to conservation of heritage structures; materials, construction techniques and structural components; classical structural analysis approaches; seismic behaviour, damage and collapse mechanisms of historic buildings; modern conservation criteria and practical implementation of repair or strengthening strategies. This course is equivalent to CIVE 5202 at Carleton University.
Course Component: Lecture

CVG 7116 Fundamentals of Geomechanics (3 units)
Tensor calculus, Cauchy stress, kinematics of continuum deformation (strain), elasticity for geomaterials, plasticity for geomaterials, constitutive models for soils, Cam-clay model. This course is equivalent to CIVE 5801 at Carleton University.
Course Component: Lecture

CVG 7120 Introductory Elasticity (3 units)
This course is equivalent to CIVE 5101 at Carleton University.
Course Component: Lecture

CVG 7121 Advanced Elasticity (3 units)
This course is equivalent to CIVE 5102 at Carleton University.
Course Component: Lecture

CVG 7122 Finite Element Methods Stress Analysis (3 units)
This course is equivalent to CIVE 5103 at Carleton University.
Course Component: Lecture

CVG 7123 Earthquake Analysis and Design of Structures (3 units)
This course is equivalent to CIVE 5104 at Carleton University.
Course Component: Lecture

CVG 7124 Advanced Finite Element Analysis in Structural Mechanics (3 units)
This course is equivalent to CIVE 5105 at Carleton University.
Course Component: Lecture

CVG 7125 Theory of Structural Stability (3 units)
This course is equivalent to CIVE 5203 at Carleton University.
Course Component: Lecture

CVG 7126 Behaviour of Steel Structure (3 units)
This course is equivalent to CIVE 5204 at Carleton University.
Course Component: Lecture

CVG 7127 Analysis of Elastic Structures (3 units)
This course is equivalent to CIVE 5205 at Carleton University.
Course Component: Lecture

CVG 7128 Prestressed Concrete (3 units)
This course is equivalent to CIVE 5206 at Carleton University.
Course Component: Lecture

CVG 7129 Advanced Structural Design (3 units)
Course Component: Lecture

CVG 7130 Advanced Reinforced Concrete (3 units)
This course is equivalent to CIVE 5208 at Carleton University.
Course Component: Lecture

CVG 7131 Project Management (3 units)
This course is equivalent to CIVE 5600 at Carleton University.
Course Component: Lecture

CVG 7132 Computer-Aided Design of Building Structures (3 units)
Course Component: Lecture

CVG 7137 Dynamics of Structures (3 units)
This course is equivalent to CIVE 5106 at Carleton University.
Course Component: Lecture

CVG 7138 Engineered Masonry Behaviour and Design (3 units)
This course is equivalent to CIVE 5200 at Carleton University.
Course Component: Lecture

CVG 7139 Behaviour and Design of Steel Structures (3 units)
Course Component: Lecture

CVG 7140 Statistics, Probabilities and Decision-Making (3 units)
This course is equivalent to CIVE 5601 at Carleton University.
Course Component: Lecture

CVG 7141 Advanced Methods in Computer-Aided Design (3 units)
This course is equivalent to CIVE 5602 at Carleton University.
Course Component: Lecture

CVG 7142 Engineering Management (3 units)
Course Component: Lecture

CVG 7143 Design of Steel Bridges (3 units)
This course is equivalent to CIVE 5605 at Carleton University.
Course Component: Lecture

CVG 7144 Design of Concrete Bridges (3 units)
This course is equivalent to CIVE 5606 at Carleton University.
Course Component: Lecture

CVG 7145 Introduction to Bridge Design (3 units)
This course is equivalent to CIVE 5607 at Carleton University.
Course Component: Lecture

CVG 7150 Intercity Transportation, Planning and Management (3 units)
This course is equivalent to CIVE 5304 at Carleton University.
Course Component: Lecture

CVG 7151 Traffic Engineering (3 units)
This course is equivalent to CIVE 5305 at Carleton University.
Course Component: Lecture

CVG 7152 Highway Materials (3 units)
This course is equivalent to CIVE 5306 at Carleton University.
Course Component: Lecture

CVG 7153 Urban Transportation and Management (3 units)
This course is equivalent to CIVE 5307 at Carleton University.
Course Component: Lecture

CVG 7154 Geometric Design (3 units)
This course is equivalent to CIVE 5308 at Carleton University.
Course Component: Lecture

CVG 7155 Intercity Transportation Supply (3 units)
This course is equivalent to CIVE 5309 at Carleton University.
Course Component: Lecture

CVG 7156 Transportation Economics and Policy (3 units)
This course is equivalent to CIVE 5401 at Carleton University.
Course Component: Lecture

CVG 7158 Airport Planning (3 units)
This course is equivalent to CIVE 5403 at Carleton University.
Course Component: Lecture

CVG 7159 Transportation Terminal (3 units)
This course is equivalent to CIVE 5402 at Carleton University.
Course Component: Lecture

CVG 7160 Biofilm Processes in Waste-Water Treatment (3 units)
This course is equivalent to ENVE 5001 at Carleton University.
Course Component: Lecture

CVG 7163 Case Studies in Hydrogeology (3 units)
This course is equivalent to ENVE 5302 at Carleton University.
Course Component: Lecture

CVG 7164 Multiphase Flow and Contaminant Transport Modelling (3 units)
Course Component: Lecture

CVG 7170 Fundamentals of Fire Safety Engineering (3 units)
This course is equivalent to CIVE 5609 at Carleton University.
Course Component: Lecture

CVG 7171 Fire Dynamics I (3 units)
This course is equivalent to CIVE 5610 at Carleton University.
Course Component: Lecture

CVG 7172 Fire Dynamics II (3 units)
This course is equivalent to CIVE 5613 at Carleton University.
Course Component: Lecture

CVG 7173 People in Fires (3 units)
This course is equivalent to CIVE 5611 at Carleton University.
Course Component: Lecture

CVG 7174 Fire Modelling (3 units)
This course is equivalent to CIVE 5612 at Carleton University.
Course Component: Lecture

CVG 7175 Design for Fire Resistance (3 units)
This course is equivalent to CIVE 5614 at Carleton University.
Course Component: Lecture

CVG 7181 Nonlinear Analysis and Design of Advanced Earthquake-Resistant Structures (3 units)
Nonlinear Analysis and Design of Advanced Earthquake-Resistant Structures. Design and construction of nonlinear structural models. Accounting for mass, material behavior, damping, and nonlinear geometry. Use of pushover and time history analysis methods. Design and modelling of structural systems using passive damping devices and isolation systems.
Course Component: Lecture

CVG 7182 Introduction to Infrastructure Management (3 units)
Infrastructure management and its relationship to facility and asset management; challenges facing infrastructure managers; tools for effective IM; concept of total quality management; economic analysis of maintenance, rehabilitation and reconstruction; use of life cycle cost analysis in decision making, development and use of IM systems.
Course Component: Lecture

CVG 7183 Seepage Through Soils (3 units)
Surface-subsurface water relations. Steady flow. Flownet techniques. Numerical techniques. Seepage analogy models. Anisotropic and layered soils. Water retaining structures. Safety against erosion and piping. Filter design. Steady and non-steady flow towards wells. Multiple well systems. Subsidence due to ground water pumping.
Course Component: Lecture

CVG 7184 Blast Load Effects on Structures (3 units)
Threats, risk analysis, vulnerability assessment; explosives: types and mechanisms; load determination; response of structural elements under blast loads, analysis and design for blast loads; blast mitigation, retrofit of structures; post-event assessment.
Course Component: Lecture

CVG 7185 Topics in Fire Safety (3 units)
Courses in special topics related to fire safety, not covered by other graduate courses.
Course Component: Lecture

CVG 7300 Special Topics in Civil Engineering (3 units)
This course is equivalent to CIVE 5705 at Carleton University.
Course Component: Laboratory, Lecture

CVG 7301 Special Topics in Civil Engineering (3 units)
Course Component: Lecture

CVG 7302 Special Topics in Civil Engineering (3 units)
Course Component: Lecture

CVG 7303 Special Topics in Civil Engineering (3 units)
Course Component: Lecture

CVG 7304 Special Topics in Civil Engineering (3 units)
Course Component: Lecture

CVG 7305 Special Topics in Civil Engineering (3 units)
Course Component: Lecture

CVG 7306 Special Topics in Civil Engineering (3 units)
Course Component: Lecture

CVG 7307 Special Topics in Civil Engineering (3 units)
Course Component: Lecture

CVG 7308 Special Topics in Civil Engineering (3 units)
Course Component: Lecture

CVG 7309 Special Topics in Civil Engineering (3 units)
Course Component: Lecture

CVG 7310 Special Topics in Civil Engineering (3 units)
Course Component: Lecture

CVG 7311 Special Topics in Civil Engineering (3 units)
Course Component: Lecture

CVG 7312 Special Topics in Civil Engineering (3 units)
Course Component: Lecture

CVG 7313 Special Topics in Civil Engineering (3 units)
Course Component: Lecture

CVG 7314 Special Topics in Civil Engineering (3 units)
Course Component: Lecture

CVG 7315 Special Topics in Civil Engineering (3 units)
Course Component: Lecture

CVG 7316 Special Topics in Civil Engineering (3 units)
Course Component: Lecture

CVG 7317 Special Topics in Civil Engineering (3 units)
Course Component: Lecture

CVG 7318 Special Topics in Civil Engineering (3 units)
Course Component: Lecture

CVG 7319 Special Topics in Civil Engineering (3 units)
Course Component: Lecture

CVG 7320 Special Topics in Civil Engineering (3 units)
Course Component: Lecture

CVG 8366 Doctoral Seminar in Civil Engineering
Attendance and participation in the monthly seminar. All students must make one presentation and continue to attend throughout the program. Graded S (Satisfactory) / NS (Not satisfactory).
Course Component: Seminar

CVG 9998 Examen général de doctorat / Comprehensive Examination (Phd)
Ce cours est équivalent à CIVE 6902 à la Carleton University. / This course is equivalent to CIVE 6902 at Carleton University.
Volet / Course Component: Recherche / Research