Department of Civil and Environmental Engineering

Chairperson: Harajli, Mohamed
Professors: Abdul Malak, Assem; Ayoub, George; Basha, Habib; El Fadel, Mutasem; Hamad, Bilal; Harajli, Mohamed; Kaysi, Isam; Mabsout, Mounir; Sadek, Salah; Suidan, Makram
Professor Emeritus: Iliya, Raja
Associate Professors: Chehab, Ghassan; Najjar, Shadi
Assistant Professors: Abou Najm, Majdi; Abou Zeid, Maya; Alameddine, Ibrahim; El-Khoury, Hiam; Hamzeh, Farook; Hantouche, Elie; Saad, George; Salam, Darine; Srour, Issam
Visiting Assistant Professor: Dabaghi, Mayssa
Part-Time Senior Lecturers: Basha, Hisham; Fawwaz, Youssef
Part-Time Lecturers: El Meski, Fatima; El Souri, Amer; Inglessis, Constantine; Nader, Halim; Karnib, Ali; Malaeb, Lilian; Nasreddine, Khaled
Laboratories: Al Hassanieh, Dima; El Khatib, Helmi

Undergraduate Programs

The Department of Civil and Environmental Engineering (CEE) offers the degrees of Bachelor of Engineering (BE), major: Civil Engineering (CE); and Bachelor of Science (BS), major: Construction Engineering (ConsE).

The mission of the undergraduate programs of the CEE Department is to provide a stimulating and supportive environment for high-standard education and research; to prepare graduates for lifelong learning and productive careers, while instilling in them an appreciation of leadership qualities, professionalism, and ethics; to provide professional services of the highest quality to the community; and to expand, through teaching and research, the knowledge and technology base in civil and environmental engineering.

Bachelor of Engineering (BE)
Specialization: Civil Engineering

Program Educational Objectives

The objectives of the CE program are to see our graduates move on to become:

- engineers who hold central positions in various sub-disciplines of civil engineering in local, regional, and international practice;
- graduates who are admitted to and successfully complete advanced degrees in leading universities around the world; and
- leaders in their profession and in the service of their community.
## Curriculum

### Term I (Fall)  
<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
<th>Description</th>
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<tbody>
<tr>
<td>FEAA 200</td>
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<td>Introduction to Engineering &amp; Architecture</td>
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<td>CIVE 210</td>
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**Humanities Elective I**  

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<td>CIVE 410</td>
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<td>EECE 231</td>
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<td>Introduction to Programming with C++ and MATLAB</td>
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<td>MATH 251</td>
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**Social Science Elective I**  

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<th>Term VI (Summer)</th>
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<td>GEOL 2nn</td>
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<tr>
<td>CIVE 413</td>
<td>Concrete Design I</td>
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<tr>
<td>CIVE 430</td>
<td>Soil Mechanics and Laboratory</td>
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<td>CIVE 440</td>
<td>Hydraulics and Laboratory</td>
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<td>CIVE 550/551</td>
<td>Water Treatment/Wastewater Treatment and Laboratory</td>
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<td>CIVE 460</td>
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<td>CIVE 41n</td>
<td>Indeterminate Structural Analysis/Steel Design/Concrete Design II</td>
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<tr>
<td>CIVE 431</td>
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<td>CIVE 541/542</td>
<td>Engineering Hydrology/Urban Hydrology</td>
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<td>CIVE 401</td>
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<td>CIVE 421</td>
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<td>CIVE</td>
<td>CEE Technical Elective I</td>
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**Total Credit Hours: 143**
Bachelor of Science (BS)
Specialization: Construction Engineering (ConsE)

Program Educational Objectives
The objectives of the Construction Engineering program are to see our graduates move on to become:

- engineers who hold central positions in local, regional, and international construction engineering practice;
- engineers who are involved in landmark projects and who contribute to the advancement of the local and regional construction industry; and
- leaders in their profession and in the service of their community.

Curriculum

<table>
<thead>
<tr>
<th>Term I</th>
<th>Fall</th>
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<tr>
<td>FEAA</td>
<td>200 Introduction to Engineering &amp; Architecture</td>
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<td>CIVE</td>
<td>210 Statics</td>
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<td>MATH</td>
<td>201 Calculus and Analytical Geometry III</td>
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<td>202 Introduction to Environmental Chemistry</td>
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<th>Term II</th>
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<tr>
<td>CIVE</td>
<td>201 Engineering Drawings and Tools</td>
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<td>202 Differential Equations</td>
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<th>Term III</th>
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<tr>
<td>CIVE</td>
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<td>230 Introduction to Probability and Random Variables</td>
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<tr>
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<td>CIVE</td>
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<td>Introduction to Programming with C++ and MATLAB</td>
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<tr>
<td>CIVE</td>
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<th>Term VII</th>
<th>Fall</th>
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<tr>
<td>CIVE</td>
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<td>CIVE</td>
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<th>Term VIII</th>
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<tr>
<td>CIVE</td>
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**Total Credit Hours: 110**

**Elective Courses**

- **List of Biology Elective Courses:** BIOL 201, BIOL 202, BIOL 209, BIOL 210, BIOL 250, BIOL 252, BIOL 255, BIOL 258, BIOL 259, CIVE 252
- **List of Chemistry Elective Courses:** CHEM 202, CIVE 251
- **List of Geology Elective Courses:** GEOL 201, GEOL 211, CIVE 330
- **List of Mathematics Elective Courses:** MATH 211, MATH 212, MATH 218, MATH 281

Undergraduate Catalogue 2015–16
Course Descriptions

Common Courses

FEAA 200  Introduction to Engineering and Architecture  3 cr.
The course is designed to familiarize first year students with the different disciplines in Engineering and Architecture, including: Architecture, Civil, Mechanical, Electrical, Chemical, Industrial, and technologies used in the fields. It has an interdisciplinary nature bringing ideas and solutions from all disciplines in engineering and architecture. It also introduces the student to basic engineering tools such as MATLAB, LabVIEW, and some basic laboratory instruments.

CIVE 201  Engineering Drawings and Tools  3 cr.
An introductory course that aims to introduce students to the basics of engineering drawing and mapping through the use of Autodesk’s Revit and ESRI’s ArcGIS software packages.

CIVE 301  Surveying  2 cr.
A course on the theory of measurements and errors; linear measurements; surveying instruments; leveling; angles, bearings, and azimuths; stadia measurements; traversing-field aspects; traverse computations and adjustment; topographic surveying; triangulation. Prerequisites: CIVE 201 and CIVE 210.

CIVE 400  Approved Experience  0 cr.
Students are placed for eight full weeks at a recognized consulting and/or contracting firm in Lebanon or abroad, in a capacity that ensures they apply their knowledge and acquire professional experience in the field of Civil Engineering. Prerequisite: E4 Status.

CIVE 401  Final Year Project I  3 cr.
A chosen design topic and preparation of a detailed execution program for CIVE 402, through comprehensive research with the guidance and approval of the faculty. Prerequisite: CIVE 400.

CIVE 402  Final Year Project II  3 cr.
A supervised project in groups of normally three students aimed at providing practical design experience in a civil and environmental engineering application. Prerequisite: CIVE 401.

CIVE 403  Special Topics in Civil and Environmental Engineering  3 cr.

CIVE 501  Computer Methods in Civil Engineering  3 cr.
A course on the use of computers for analysis, design, and decision making in civil engineering, including programming, numerical, and CAD methods and applications. Prerequisite: EECE 231.

CIVE 600A  Seminar in Civil Engineering  0 cr.
A seminar that consists of current research or applied projects presented by faculty members, students, or invited speakers.

CIVE 600B  Seminar in Environmental Engineering and Sciences  0 cr.
A seminar that consists of current research or applied environmental projects presented by faculty members, students, or invited speakers.
CIVE 601  GIS and Geospatial Data Modeling  3cr.
A course that examines the concepts and principles of Geographic Information System (GIS). It provides coverage of state-of-the-art GIS methods and tools: spatial and terrain analysis, geostatistical analysis, time series analysis, and development of GIS integrated models.

CIVE 602  Experimental Design and Statistical Analysis for Engineers  3 cr.
A course that covers the main steps required to efficiently plan, conduct, analyze, and interpret the results from experiment and observational studies. The course focuses on statistical inference and modeling. Topics covered include ANOVA, t-tests, regression models, and non-parametric tests. The course involves working within a statistical modeling environment.

CIVE 603  Numerical Modeling  3 cr.
A course that deals with ordinary differential equations: initial-, boundary-, and characteristic-value problems; partial differential equations: steady state, time dependent, and oscillatory problems; techniques: Runge-Kutta, shooting, iterative, and finite difference methods. Prerequisite: MATH 251.

Structural Sequence

CIVE 210  Statics  3 cr.
A course outlining vector mechanics of forces and moments; free-body diagrams; equilibrium of particles and rigid bodies in two and three dimensions; plane and space trusses; frames and machines; axial, shear, moment diagrams of beams and simple frames; friction; center of gravity and centroid; area moment of inertia; computer applications. Pre- or corequisite: MATH 201.

CIVE 310  Mechanics of Materials  3 cr.
A course on stresses, strains, and stress-strain relationships; temperature; axial bars in tension and compression; torsion of circular bars; bending and shear stresses in beams; combined stresses; stress transformation and Mohr’s circle; and computer spreadsheet. Prerequisite: CIVE 210.

CIVE 410  Theory of Structures  3 cr.
A course covering review of principles of statics; analysis of statically determinate plane frames; deflection of statically determinate beams; Introduction to indeterminate structural analysis; Influence lines; Computer applications; a Project on Building modeling and assessment. Prerequisites: CIVE 310, MATH 202, and PHYS 210.

CIVE 411  Indeterminate Structural Analysis  3 cr.
A course covering review of basic concepts of structural analysis; equilibrium, stability, indeterminacy and degrees of freedom; indeterminate analysis of trusses; Indeterminate analysis of beams and frames; influence lines for statically Indeterminate structures. Prerequisite: CIVE 410.

CIVE 412  Steel Design  3 cr.
A course that examines loads on structures; philosophies of design: LRFD versus ASD; behavior, analysis, and design (according to AISC) of tension members, bolted connections, welded connections, welding fundamentals and groove welds, compression members, and beams. Prerequisite: CIVE 410.
CIVE 413  Concrete Design I  3 cr.
A course that covers the mechanical properties of concrete materials; ultimate strength theory of flexure and shear; flexural and shear design of beams; service load behavior; bond properties of reinforcing bars; design of solid and ribbed one-way slabs. *Prerequisite: CIVE 410.*

CIVE 414  Concrete Design II  3 cr.
A course that covers continuous beams, short columns, ladder columns, and biaxially bent columns; wall footings, concentrically and eccentrically loaded single column footings, and combined footings; staircases; bearing walls; cantilever retaining. *Prerequisite: CIVE 413.*

CIVE 610  Numerical Methods in Structural Analysis  3 cr.
A course that introduces the matrix approach for the modeling and analysis of structural systems; computer modeling/analysis using specialized software (SAP2000); computer implementation and code development; nonlinear analysis of frames. *Prerequisites: CIVE 411 and EECE 231.*

CIVE 611  Bridges  3 cr.
A course that discusses types of bridges; influence lines; loads and their distribution on bridges; serviceability of bridges; methods of design of bridge deck, superstructure, and substructure. *Prerequisite: CIVE 410.*

CIVE 612  Advanced Steel Design  3 cr.
A course that investigates stability, column strength, beam-columns, composite steel-concrete construction, plate buckling, plate girders, torsion, and combined torsion and bending, eccentrically loaded connections, influence of connection stiffness on moment demand, and general moment connection. *Prerequisite: CIVE 412.*

CIVE 613  Prestressed Concrete  3 cr.
A course on material characteristics; prestress losses; working strength design procedures; composite construction; ultimate flexural strength and behavior; shear design; continuous prestressed concrete members. *Prerequisite: CIVE 413.*

CIVE 614  Special Topics in Concrete  3 cr.
A course that reviews reinforced concrete (R/C) design; torsion in R/C members; wind load on structures; earthquake load and seismic design of structures; design of shear walls; design of corbels, brackets and deep girders; circular and rectangular water tanks; and spherical. *Prerequisite: CIVE 414.*

CIVE 615  Strengthening and Rehabilitation of Concrete Structural Systems  3 cr.
A course on assessment of materials and structural deficiency using field test or analytical methods; repair and strengthening materials; strengthening and repair techniques; strengthening of structural members in flexure, shear and axial load; and upgrading of gravity load-designed buildings for earthquake load resistance. *Prerequisites: CIVE 410 and CIVE 413.*

CIVE 616  Earthquake Engineering  3 cr.
A course that examines the nature of earthquake ground motion; seismic hazard evaluation in engineering practice; response analysis of structures and effect of soil conditions on structural response and behavior under earthquake ground motion; design of structures under earthquake loading.
CIVE 710  The Finite Element Method  3 cr.
A course that introduces basic elements; interpolation and shape functions; variational formulation methods; Galerkin and weighted residual Methods; isoparametric elements; numerical integration; error estimation and modeling issues; finite elements in structural dynamics. Prerequisite: CIVE 610.

CIVE 711  Advanced Mechanics of Solids  3 cr.
A course that covers theories of stress and strain; generalized Hook's law; modes of failure, failure criteria; energy principles and applications; torsion; beams on elastic foundations; introduction to the theory of plates; thin-wall and thick-wall cylinder.

CIVE 712  Structural Dynamics  3 cr.
A course on analysis of vibration of single degree, multi-degree, and infinite degree of freedom systems; free and forced vibration response; analysis of dynamic response by approximate methods; introduction to earthquake engineering.

CIVE 713  Behavior of Reinforced Concrete Members  3 cr.
A course on building codes; limit state design; mechanical characteristics of concrete and steel reinforcement; creep and shrinkage; flexure: moment-curvature and force-deformation relationships; columns: axial force-moment-curvature relationships; shear: mechanisms of shear resistance, and truss analogy; bond and anchorage of reinforcement. Prerequisite: CIVE 414.

Construction Engineering and Management Sequence

CIVE 421  Construction Management  3 cr.
A course that seeks to impart in students a sound understanding of the construction company and project organization, pre-construction activities, estimating and bidding, staffing for construction, macro-level planning and scheduling, and quality control.

CIVE 520  Construction Contract Administration  3 cr.
The course deals with contract documents, with focus on specifications structure, procedural requirements, specifying methods, and the basis for unit rate estimation. It covers the Engineer's roles along with contract administration issues. Prerequisite: CIVE 421.

CIVE 521  Construction Methods and Safety Management  3 cr.
A course that exposes students to the tools needed for estimating, planning and directing operations in building construction and heavy civil projects. The course addresses equipment, methods, productivity, ownership and operating costs, and safety management. Prerequisite: CIVE 370.

CIVE 522  Building Construction and Estimating  3 cr.
A course that exposes students to different building systems (concrete, masonry, steel, waterproofing, mechanical and electrical, etc.) and how to price them by choosing the best materials and methods. The use of drawings and specifications will also be covered. Prerequisites: CIVE 400 (site work) and CIVE 421.
CIVE 523  Construction Planning and Scheduling  3 cr.
A course on CPM, precedence network, schedule control, codes, collaborative planning, resource management, priority rules and leveling, earned value, schedule reduction, PERT, line of balance scheduling, the Last Planner System, Primavera P6, Microsoft Project, and VICO control.

CIVE 524  Logistics, Technologies, and Productivity Concepts  3 cr.
The course covers construction site layout, team organization, information flow, and complexities. Focus is on productivity improvement approaches, data gathering for analysis of construction operations, issues related to process innovation and automation.

CIVE 525  Design of Temporary Support Structures  3 cr.
A course that covers design and construction of temporary support structures used in the construction industry, including concrete formwork, scaffolding, caissons, cofferdams, and dewatering systems.

CIVE 620  Pre-Project Planning and Feasibility Analysis  3 cr.
A course covering the studies needed to make a go-ahead decision, including assimilation of client needs, surveys of project area and infrastructure conditions, scope validation, team development, project planning and cost estimation, and financial feasibility. Prerequisite: CIVE 421 or equivalent.

CIVE 621  Design Management for Large Projects  3 cr.
The course covers the characteristics of the design phase, design team selection, and design services agreement formation and negotiation. It focuses on value engineering and management, constructability considerations, and project cost management during design.

CIVE 622  Advanced Topics in Construction Management (Blended)  3 cr.
A course focusing on the construction phase of a project’s life cycle. Topics include: site organization structure, construction safety, labor management, materials procurement systems, site information management, scheduling, project controls, and sustainability. Prerequisite: CIVE 421 or equivalent.

CIVE 623  Construction Project Management  3 cr.
The course offers an extended overview of project management. It covers integrated planning-estimating-scheduling concept; project time, budget, and quality baselines; materials management and subcontracting issues; and integrated project cost-time control. Prerequisite: CIVE 421 or equivalent.

CIVE 624  Building Information Modeling  3 cr.
A course that covers Building Information Model (BIM) use and benefits in design and construction. It addresses collaborative design, clash detection, level of development (LOD), BIM contracts, automated code checking, simulation, BIM and lean applications, and integrated project delivery.

CIVE 625  IT Applications in Construction  3 cr.
A course that covers computing tools impacting the construction industry such as mobile sensing, instrumentation and information systems to support field engineering tasks and computerized systems applications to perform specific functions, such as estimating, scheduling, and cost control.
CIVE 626 Lean Construction Methods and Applications (Blended) 3 cr.
A course on lean theory, production control, value stream mapping, process improvement, project definition, lean design, integrated project delivery, advanced lean scheduling, risk assessment, budget under uncertainty, and project monitoring. Prerequisite: CIVE 421.

CIVE 627 Construction Systems Analysis and Simulation 3 cr.
A course that covers planning and simulation modeling of construction operations, design of efficient processes, construction productivity and resource use considerations, production system design, construction supply chain management, and analysis of construction systems.

CIVE 628 Sustainable Building Design and Construction 3 cr.
A course that covers principles of sustainable design and construction, including life-cycle assessment, economic and environmental impacts, carbon footprint, and green building rating systems such as LEED and BREEAM.

CIVE 629 Construction Business Management 3 cr.
A course that covers the principles of business management of construction companies and projects including financial management, accounting, costs and profits management, cash flows management, evaluation of sources of construction funding, and financial decisions analysis. Prerequisite: CIVE 370.

CIVE 720 Construction Technology for Tall Buildings 3 cr.
A course on the latest construction practices and processes for tall buildings from foundation to roof. It covers advanced methods, materials, equipment, and systems used for the construction of tall buildings, as well as principles of sustainable construction. Prerequisite: CIVE 521.

CIVE 721 Advanced Scheduling Analysis 3 cr.
A course that provides advanced techniques in construction scheduling. It examines monitoring, updating, and controlling the project schedule. It introduces the methods used in performing forensic scheduling analysis. Prerequisite: CIVE 523.

CIVE 722 Project Deliverance and Contracts 3 cr.
The course offers an overview of project delivery organizations, risk considerations, and contracts. It covers the elements of construction contracts, with emphasis on contract formation, substantial completion, and close-out processes. Prerequisite: CIVE 421 or equivalent.

CIVE 723 Dispute Resolution on Projects 3 cr.
The covers construction contract conditions governing claims and disputes. Focus is on claim evolvement and administration (including issues dealing with time barring, notification, and substantiation) and ADR methods and amicable settlement. Prerequisite: CIVE 520.

CIVE 724 Mediation of Engineering Disputes 3 cr.
This course focuses on the use of mediation for resolving construction related disputes. Topics include: dispute avoidance in construction, alternative dispute resolution techniques, and the mechanics of mediation and negotiation. Prerequisite: CIVE 520.

CIVE 725 Construction Decisions under Uncertainty 3 cr.
A course that covers construction project and organization decisions for the uncertain future. The course addresses decision theory, competitive bid analysis, probabilistic modeling and simulation, and multiple regression analysis in managing construction. Prerequisite: STAT 230.
# Geotechnical Sequence

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIVE 330</td>
<td>Engineering Geology</td>
<td>3 cr.</td>
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<tr>
<td></td>
<td>A course that discusses the composition and properties of rocks; geologic processes; geologic hazards; geologic structure and engineering consequences; terrain analysis and geologic mapping; interpretation and use of geologic maps; application of geology to engineering practice.</td>
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<tr>
<td>CIVE 430</td>
<td>Soil Mechanics and Laboratory</td>
<td>3 cr.</td>
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<td></td>
<td>A course on soil classification and index properties; soil structure and moisture; compaction; seepage; effective stress concept; compressibility and consolidation; stress and settlement analysis; shear strength; and laboratory experiments. <em>Prerequisites: CIVE 310 and CIVE 330.</em></td>
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<tr>
<td>CIVE 431</td>
<td>Foundation Engineering</td>
<td>3 cr.</td>
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<td></td>
<td>A course that covers site investigations; evaluation of data from field and laboratory tests; estimation of stresses in soil masses; applications of principles of soil mechanics to determination of bearing capacity and settlement of spread footings, mats, single piles, and pile groups. <em>Prerequisite: CIVE 430.</em></td>
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</tr>
<tr>
<td>CIVE 631</td>
<td>Applied Foundation Engineering</td>
<td>3 cr.</td>
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<tr>
<td></td>
<td>A course on braced excavations, retaining structures, deep foundations, slope stability, and computer applications. <em>Prerequisite: CIVE 431.</em></td>
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<tr>
<td>CIVE 632</td>
<td>Soil Behavior</td>
<td>3 cr.</td>
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<td></td>
<td>A course on soil mineralogy, soil formation, and composition; influence of geological factors on properties; colloidal phenomena in soils; soil structure; analysis of conduction phenomena (hydraulic, diffusive, thermal, and electrical); compressibility, strength, and deformation properties. <em>Prerequisite: CIVE 430.</em></td>
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<tr>
<td>CIVE 633</td>
<td>Soil and Site Improvement</td>
<td>3 cr.</td>
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<td></td>
<td>A course that covers compaction, admixture stabilization, foundation soil treatment, reinforced soil and composite materials, and material sites reclamation.</td>
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<tr>
<td>CIVE 634</td>
<td>Shear Strength of Soils</td>
<td>3 cr.</td>
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<td></td>
<td>A course that covers stresses within a soil mass, tests to measure stress strain properties, stress-strain relationships, shear strength, drained conditions, undrained, constitutive models, and failure criteria applications. <em>Prerequisite: CIVE 430.</em></td>
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<tr>
<td>CIVE 635</td>
<td>Earth Dams</td>
<td>3 cr.</td>
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<tr>
<td></td>
<td>A course that examines hydraulic dams, rolled earth dams, homogenous dams, thin core dams, filters, causes of dam failures, seepage control, and seismic stability of dams.</td>
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<tr>
<td>CIVE 636</td>
<td>Geotechnical Earthquake Engineering</td>
<td>3 cr.</td>
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<tr>
<td></td>
<td>A course on causative mechanisms and characteristics of earthquakes; evaluation dynamic soil properties local site response; seismic soil-structure interaction; evaluation and mitigation of soil liquefaction; seismic code provisions and additional current topics. <em>Prerequisite: CIVE 430.</em></td>
<td></td>
</tr>
</tbody>
</table>
## Water Resources Sequence

**CIVE 340**  
**Fluid Mechanics and Laboratory**  
A course that deals with fluid properties, fluid static, continuity equation, Bernoulli’s equation, energy principle, momentum principle, laboratory experiments. *Prerequisites: MATH 201 and PHYS 210.*

**CIVE 440**  
**Hydraulics and Laboratory**  
A course that covers flow in conduits, flow in open channels, flow measurements, design of basic hydraulic structures, and laboratory experiments. *Prerequisites: CIVE 340, MATH 202, and ENGL 206.*

**CIVE 541**  
**Engineering Hydrology**  
A course outlining hydrologic principles, rainfall-runoff analysis, flood routing, frequency analysis, and ground water hydrology. *Prerequisites: CIVE 340 and MATH 202.*

**CIVE 542**  
**Urban Hydrology**  
A course covering design rainfall, infiltration, overland flow, channel flow, storm sewer hydraulics, stormwater detention, and simulation models. *Prerequisite: CIVE 440.*

**CIVE 640**  
**Advanced Hydraulics**  
A course that covers closed conduit flow, water distribution systems, transient analysis, open channel flow, flood control, culvert hydraulics, design of various hydraulic structures. *Prerequisite: CIVE 440.*

**CIVE 641**  
**Surface Water Hydrology**  
A course on design storm, rainfall-runoff modeling, flood routing, reservoir routing, simulation models, and stochastic hydrology. *Prerequisite: CIVE 441 or equivalent.*

**CIVE 642**  
**Groundwater Hydrology**  
A course that deals with properties of groundwater, Darcy’s law, steady groundwater flow, unsteady groundwater flow, well hydraulics, unsaturated flow, sea-water intrusion, and numerical modeling. *Prerequisite: CIVE 441.*

**CIVE 644**  
**Coastal Engineering**  
A course on small-amplitude wave theory (linear theory); finite-amplitude wave theory (nonlinear theory); cnoidal wave theory; solitary wave theory; wave refraction, diffraction, and reflection; wave forces and interaction with man-made structures; and design of maritime structures e.g. breakwaters. *Prerequisite: CIVE 440.*

**CIVE 645**  
**Surface Water Quality Modeling and Management**  
An introductory course on surface water quality pollution problems in streams, rivers, lakes, reservoirs, and estuaries with a focus on both the quantitative modeling aspects of surface water quality and the management and policy aspects of it. Both mechanistic and empirical models for assessing the status of surface water bodies are introduced.

**CIVE 647**  
**Water Resource Systems: Planning and Management**  
A course that introduces principles demonstrating steps in engineering policy planning as it applies to water resources management. Emphasis will be placed on systems and socio-economics analysis, conflict management, and concepts in strategic assessment.

Undergraduate Catalogue 2015–16
**CIVE 648 Climate Change and Water Resources** 3 cr.
An introductory course on global climate change and its potential impacts on water resources and related sectors. It explores drivers of climate change, greenhouse gases emissions and mitigation efforts, and adaptation options with emphasis on Integrated Water Resources Management.

**CIVE 740 Transport Phenomena in Surface and Subsurface Waters** 3 cr.
A course on advection, diffusion, and dispersion of pollutants; transport in rivers and estuaries; transport in groundwater; numerical modeling; design of wastewater discharge system.

**Environmental Sequence**

**CIVE 251 Environmental Chemistry** 3 cr.
A course that introduces the basic principles of environmental chemistry and discusses example applications from the natural and engineered worlds.

**CIVE 252 Environmental Microbiology** 3 cr.
A course that introduces the basic principles of environmental microbiology. It discusses example applications from the natural and engineered worlds. The main goals of this course are to present an overview of important micro-organisms involved in environmental systems, their ecology, interactions with various pollutants, and beneficial or harmful effects on humans.

**CIVE 550 Water Treatment and Laboratory** 3 cr.
A course that examines the quality and principles of municipal and industrial water treatment processes and methods of testing for physical, chemical and biological parameters. **Prerequisite:** CIVE 251 or equivalent, or consent of instructor.

**CIVE 551 Wastewater Treatment and Laboratory** 3 cr.
A course that examines the quality and principles of municipal wastewater treatment processes and methods of testing for physical, chemical, and biological parameters. **Prerequisite:** CIVE 252 or equivalent, or consent of instructor.

**CIVE 552 Waste Management and Treatment** 3 cr.
A course on engineering principles, practices, and techniques for the management of solid wastes: sources, composition, properties, impacts, generation, storage, collection and transport, processing, resource recovery, and disposal.

**CIVE 553 Biotechnology Principles in Biochemical and Environmental Engineering** 3 cr.
A course designed to teach students the biotechnology principles in biochemical and environmental engineering. Emphasis is placed on enzyme kinetics and technology, bioreaction kinetics, design and analysis of bioreactors, mass transfer limitations, and downstream processing of bioreaction products. **Prerequisite:** CIVE 252 or equivalent, or consent of instructor.

**CIVE 555 Air Quality Management** 3 cr.
A course on the principles, practices, and techniques for the management of air pollution: Types, sources, properties, impacts, standards, control technologies, atmospheric dispersion, emissions, and indoor air quality.
CIVE 650  Water and Sewage Works Design  3 cr.
A course that examines the design of water and wastewater schemes, including design reports and a literature search on the development of conventional treatment processes. **Prerequisites:** CIVE 550 and CIVE 551, or consent of instructor.

CIVE 651  Processes in Water and Wastewater Treatment  3 cr.
A course on sedimentation, filterability, permeability and fluidization, ion exchange, aeration, flotation, membrane filtration, and aerobic digestion. Experimental applications of processes. **Prerequisites:** CIVE 251 and CIVE 252, or equivalent; or consent of instructor.

CIVE 652  Landfill Engineering Design  3 cr.
A course on solid waste disposal with emphasis on design development of landfill elements (site selection and characterization, gas extraction and management, leachate collection and management, liners, covers, closure and post-closure monitoring. **Prerequisite:** consent of instructor.

CIVE 653  Environmental Chemistry and Microbiology  3 cr.
A course that deals with organic, inorganic, and physical chemistry; chemical equilibrium; reaction kinetics; acidity, alkalinity; composition, morphology, and classification of microorganisms; energy, metabolism, and synthesis; growth, decay, and kinetics; and biological water quality indicators. **Prerequisites:** CIVE 251 and CIVE 252, or equivalent; or consent of instructor.

CIVE 654  Environmental Bioremediation  3 cr.
A course that discusses the application of biological treatment for the remediation of contaminated environments, and highlights current engineering methods/design used to enhance biodegradation. **Prerequisites:** CIVE 251 and CIVE 252, or equivalent; or consent of instructor.

CIVE 655  Air Pollution and Control  3 cr.
A course that examines processes and design equipment for the control of particulates and gaseous emissions. **Prerequisite:** consent of instructor.

CIVE 656  Environmental Impact Assessment  3 cr.
A course on procedures of assessing/preparing/reviewing/presenting environmental impacts of developmental projects/facilities: industrial facilities, waste management/disposal, wastewater treatment, transportation, dams and reservoirs, irrigation/drainage schemes, coastal zone developments, natural resource management, etc. **Prerequisite:** E4 status or consent of instructor.

CIVE 657  Methods of Environmental Sampling and Analysis  3 cr.
A course on sampling techniques and instrumental methods in environmental sciences; determination of pollutants in water, air, and soil; analytical techniques; adaptation of procedures to specific matrices; case studies. **Prerequisites:** CIVE 251 and CIVE 252, or equivalent; or consent of instructor.

CIVE 658  Industrial Waste Management  3 cr.
A course on engineering principles, practices, and techniques for the management of industrial-hazardous wastes: sources, generation, properties, impacts and auditing of industrial facilities. Basic treatment processes and disposal methods. Site remediation. **Prerequisite:** E4 status or consent of instructor.
CIVE 659  Environmental and Water Conflict Management  3 cr.
A course on the development of case studies in environmental and water conflict management taught under a framework of role play of opponents perspective and decision making thereof.

CIVE 751  Wastewater Reclamation and Reuse  3 cr.
A course that examines environmental issues in water reuse, risk assessment, water reclamation technologies, storage of reclaimed water, usage of reclaimed water, and planning of wastewater reclamation and reuse. Prerequisite: CIVE 551.

CIVE 755  Air Pollution Modeling  3 cr.
A course that deals with mathematical models, air pollution meteorology, plume rise, dispersion and atmospheric chemistry, meteorological models, as well as Gaussian, statistical, and other special application models. Prerequisite: CIVE 555 or consent of instructor.

Transportation Sequence

CIVE 460  Transportation Engineering and Laboratory  3 cr.
An introductory course to the field of transportation engineering through presenting the basics of traffic engineering, traffic flow theory, and airport planning. The laboratory component consists of field experiments that reinforce students' understanding of the academic concepts and principles. Prerequisites: STAT 230 and ENGL 206.

CIVE 461  Highway Engineering  3 cr.
A course that examines road vehicle performance; principles of geometric design and highways; horizontal and vertical alignment; earthwork; intersections and interchanges; pavement design; parking facilities; and highway planning (travel demand forecasting). Prerequisites: CIVE 201 and CIVE 301.

CIVE 661  Urban Transportation Planning I  3 cr.
An introductory course on methods and models used in transportation planning with emphasis on the urban context. Topics include travel patterns in urban areas; data requirements for planning and data collection techniques; transportation/land-use interaction; travel demand and network models; transport supply options; and evaluation techniques. Prerequisites: CIVE 460 and CIVE 461.

CIVE 662  Traffic Engineering  3 cr.
A course outlining traffic engineering studies; traffic control of signalized and unsignalized intersections; signal control hardware and maintenance; arterial performance and operations; and network optimization. Prerequisite: CIVE 460.

CIVE 663  Transportation Systems Analysis  3 cr.
A course that introduces methods, models, and applications of transportation systems analysis focusing on both supply/performance and demand/economics. Prerequisites: CIVE 460 and CIVE 461.
CIVE 664  Design and Management of Transport Operations  3 cr.
A course on probabilistic and optimization methods for designing efficient operations in freight carrier, airline, transit, and traffic modes. Topics include crew and vehicle scheduling in freight, airline, transit modes; vehicle routing and facility location problems in carrier systems; runway and air traffic operations; and reliability in transit services. Prerequisites: CIVE 460 and STAT 230, or equivalent.

CIVE 665  Transportation Economics  3 cr.
A course that investigates the application of economic principles to the evaluation of projects and policies in the transport sector such as transport project benefits, costs, and financing, and pricing in the transport sector. Prerequisite: CIVE 461.

CIVE 666  Public Transportation  3 cr.
A course on public transportation modes and services; single route, network, and strategic planning; tasks involved in system operations; management of public transportation organizations; privatization issues. Prerequisites: CIVE 460 and CIVE 461.

CIVE 761  Urban Transportation Planning II  3 cr.
A course examining advanced topics in urban transportation planning; transportation systems management techniques; travel demand analysis; and discrete choice modeling of travel demand. Prerequisite: CIVE 661.

CIVE 762  Traffic Flow Theory  3 cr.
A course on characteristics of traffic flow, density, and speed; models describing traffic flows; hydrodynamic analogue; and computer simulation models. Prerequisite: CIVE 460.

Materials Sequence

CIVE 370  Construction Materials and Technologies  3 cr.
An introductory course on the composition and properties of engineering materials such as asphalt, cement, concrete, geological materials, steel, polymers, and wood. Hands on laboratory experiments and demonstrations are part of the course, and are designed to familiarize the student with the materials, testing methods, equipment, and standards.

CIVE 670  Concrete Technology  3 cr.
A course that examines Portland cements; aggregates; pozzolans; proportioning normal concrete mixtures; pumping concrete; consolidating, finishing, and curing concrete; durability; testing hardened concrete; high-strength concrete; light and heavy weight concretes; and hot and cold weather concreting.

CIVE 671  Pavement Engineering  3 cr.
A course that examines highway and airport pavement design; flexible and rigid pavement types and wheel loads; stresses in flexible and rigid pavements; pavement behavior under moving loads; soil stabilization. The course covers empirical, mechanistic-empirical, and mechanistic design methodologies. Prerequisite: CIVE 461.
CIVE 672  Highway Materials and Construction  
A course that covers various materials constituents in highway pavement structures with 
emphasis on asphalt concrete, aggregate-soil mixtures, geotextiles, and bituminous liquids. 
Materials properties, design, quality control and methods of construction will be described. 
Prerequisite: STAT 230.

CIVE 770  Viscoelastic Behavior of Construction Materials  
A course that introduces students to viscoelastic behavior of construction materials, 
particularly asphalt concrete and polymer composites. The course covers basic concepts in material 
characterization, rheology, time-temperature superposition principles, in addition to linear and nonlinear viscoelastic models. Prerequisite: Graduate standing.

Multidisciplinary Courses

CIVE 481  Specifications and Cost Estimation  
A course on the structure of construction documents and their interrelationships; bidding 
requirements; general and particular contract conditions; administrative and procedural 
requirements for construction; technical specifications; construction cost estimation processes; 
and unit rates determination and pricing.

CIVE 681  Evaluation of Cost Alternatives  
A course that covers the principles of economic evaluations using concepts of time value of 
money to compare alternatives related to construction, design, and real property development.

CIVE 682  Infrastructure Systems Management  
A course on modeling and optimization methods and their application to inspection, performance 
prediction and maintenance decision making for the management of infrastructure systems.

CIVE 683  Reliability Based Design of Civil Systems  
A course that covers applications of reliability theory in assessing the safety and reliability of 
civil systems in the presence of uncertainty; decision making and risk analysis; definition of the 
probability of failure; modeling uncertainty in resistance and load; load and resistance factor 
design (LRFD) in structural and geotechnical engineering; basics of design code calibration.

CIVE 684  Environmental Geotechnics  
A course on geotechnical practice in environmental protection and restoration; influence of 
physical and chemical processes in soils on the evaluation of contaminant distribution; design 
of waste containment systems, slurry walls, and soil stabilization; the applicability and use of 
geosynthetics; and technologies for site restoration and cleanup. Prerequisite: CIVE 430.
### Special Courses

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIVE 690</td>
<td>Special Projects</td>
<td>3 cr.</td>
</tr>
<tr>
<td>CIVE 691</td>
<td>Special Topics in Civil and Environmental Engineering</td>
<td>3 cr.</td>
</tr>
<tr>
<td>CIVE 692</td>
<td>Advanced Topics in Civil and Environmental Engineering</td>
<td>3 cr.</td>
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<tr>
<td>CIVE 799</td>
<td>MS/ME Thesis</td>
<td>6 cr.</td>
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<tr>
<td>CIVE 980</td>
<td>Qualifying Exam I: Comprehensive Exam</td>
<td>0 cr.</td>
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<tr>
<td>CIVE 981</td>
<td>Qualifying Exam II: Thesis Proposal Defense</td>
<td>0 cr.</td>
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<tr>
<td>CIVE 982</td>
<td>PhD Thesis</td>
<td>3 cr.</td>
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<tr>
<td>CIVE 983</td>
<td>PhD Thesis</td>
<td>6 cr.</td>
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<tr>
<td>CIVE 984</td>
<td>PhD Thesis</td>
<td>9 cr.</td>
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<tr>
<td>CIVE 985</td>
<td>PhD Thesis</td>
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<td>CIVE 986</td>
<td>PhD Thesis</td>
<td>0 cr.</td>
</tr>
<tr>
<td>CIVE 987</td>
<td>PhD Thesis Defense</td>
<td>0 cr.</td>
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