FACULTY OF ENGINEERING

DEPARTMENT OF CIVIL ENGINEERING

Bachelor of Engineering (BE) Degree – 146 Credits

Sem	Course Code	Course Title	Credit	Pre-Req	Co-Req
1	CIVE 201	Statics	3		
1	CSIS 206	Principles of Programming	3		
1	ENGL 203	English Communication Skills III	3		
1	MATH 200	Calculus I	3		
1	MATH 211	Linear Algebra I	3		
1		Elective 1	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
2	CIVE 202	Mechanics of Materials	3	CIVE 201	
2	CIVE 203	Engineering Drawing I	1		
2	ENGL 2XX	English Elective	3	ENGL 203	
2	CIVE 290	Introduction to the Engineering Design Process	1		
2	MATH 202	Calculus II	3	MATH 200	
2	MATH 270	Differential Equations	3	MATH 200	
2		Elective 2	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
3	CIVE 204	Construction Materials and Methods	3	CIVE 202	
3	CIVE 205	Theory of Structures I	3	CIVE 202	
3	CIVE 206	Engineering Drawing II	1	CIVE 203	
3	CIVE 310	Building Laws	2	CIVE 203	
3	GENG 221	Engineering Ethics	3	CIVE 290 ENGL 203	
3	MATH 230	Numerical Analysis I	3	MATH 200 CSIS 206	
3	MATH 246	Probability For Engineers	3	MATH 200	
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
4	CIVE 208	Surveying	2	MATH 200	CIVE 214
4	CIVE 209	Reinforced Concrete I	3	CIVE 205	
4	CIVE 210	Strength of Materials Laboratory	1	CIVE 204	CIVE 209

4	CIVE 214	Surveying Laboratory	1	CIVE 203	CIVE 208
4	CIVE 243	Fluid Mechanics Laboratory	1		MECH 243
4	CIVE 301	Soil Mechanics	3		CIVE 209
4	GENG 222	Sustainable Development for Engineers	3	CIVE 290 ENGL 203	
4	LISP 200	Information Skills and Search Techniques	1		ENGL102
4	MECH 243	Fluid Mechanics	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
5	CIVE 303	Computer-Aided Design	1		CIVE 304
5	CIVE 304	Reinforced Concrete II	3	CIVE 209	
5	CIVE 306	Soil Mechanics Laboratory	1		CIVE 301
5	CIVE 309	Engineering Economy	3	MATH 200	
5	CIVE 312	Construction Management Fundamentals	2	CIVE 206 CIVE 209	
5	CIVE 316	Construction Management Modeling	1	CIVE 209	CIVE 312
5	CIVE 324	Structural Steel Design	3	CIVE 205	
5	CIVE 389	Senior Design I	2	CIVE 290 GENG 221 GENG 222	CIVE 209
5	CSPR XXX	Cultural Studies	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
6	CIVE 307	Shallow Foundation Analysis and Design	3	CIVE 209 CIVE 301	
6	CIVE 308	Transportation Engineering	3	CIVE 208	
6	CIVE 390	Senior Design II	2	CIVE 389	
6		Elective Lab 1	1		
6		Elective Lab 2	1		
6		Elective 3	2		
6		Elective 4	2		
6		Elective 5	2		
6		Elective 6	3		
Elective 1 (3 credits from the following list or any 3-credit course approved by the Department):					
	BIOL 207	General Ecology	3		ENGL 101
	EVSC 202	Fundamentals of Geology	3		ENGL 101

Elective 2 (3 credits from the following list):					
	CHEM 202	Basic Chemistry	3		
	MECH 221	Engineering Dynamics	3	CIVE 201	
Electives 3, 4, and 5 (6 credits from the following list, or any 2-credits approved by the Department):					
	CIVE 319	Revit for Civil Engineers	2	CIVE 206	
	CIVE 320	Structural Detailing	2	CIVE 206	CIVE 304 CIVE 307
	CIVE 321	Advanced Computer Aided Design	2	CIVE 303	
	CIVE 322	Technical Platform Computing for Civil Engineering	2	CSIS 206	
	CIVE 323	Introduction to Geographic Information System	2	CIVE 206 CIVE 208	
Elective 6 (3 credits from the following list):					
	CIVE 305	HVAC	3		
	CIVE 311	Sanitary Engineering	3	MECH 243	
Elective Labs 1 and 2 (2 credits from the following list, or any 1-credit Lab approved by the Department):					
	CIVE 313	Transportation Engineering Modeling	1	CIVE 206	CIVE 308
	CIVE 315	Geotechnical Engineering Modeling	1		CIVE 307
	CIVE 318	Environmental Engineering Modeling	1		
	MECH 233	Workshop Technology	1		
	PHYS 214	Fundamentals of Physics II Laboratory	1		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
7	CIVE 401	Theory of Structures II	3	CIVE 205	
7	CIVE 403	Deep Foundations	3	CIVE 307	
7	CIVE 404	Hydraulics	3		
7		Elective 7	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
8	CIVE 405	Prestressed Concrete	3	CIVE 304	
8	GENG 400	Engineering Seminars	1		
8	GENG 402	Project Management	3		

8	GENG 490	Graduation Project	3		
8		Elective 8	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
9	CIVE 480	Field Training	3		
Sem	**Course Code**	**Course Title**	**Credit**	**Pre-Req**	**Co-Req**
10	CIVE 503	Highway Design	3	CIVE 308	
10	GENG 490	Graduation Project (Re-activation)	0		
10		Elective 9	3		
10		Elective 10	3		
		TOTAL	**146**		
Elective 7 (3 credits from the following list):					
	CIVE 428	Construction Safety Management	3		
	CIVE 555	Special Topics in Engineering	3		
Elective 8 (3 credits from the following list):					
	CIVE 411	Introduction to Earthquake Engineering and Seismology	3		
	CIVE 443	Seismic Design of Reinforced Concrete Buildings	3		
Elective 9 (3 credits from the following list):					
	ENVE 401	Water Resources Engineering	3		
	CIVE 516	Advanced Geographic Information Systems	3	CIVE 323	
	CIVE 520	Principles of Environmental Engineering	3		
Elective 10 (3 credits from the following list):					
	ENVE 401	Water Resources Engineering	3		
	CIVE 410	Applied Hydraulics	3	CIVE 404	
	CIVE 411	Introduction to Earthquake Engineering and Seismology	3		
	CIVE 414	Earthquake Loss Estimations	3		
	CIVE 420	Construction Processes	3		
	CIVE 421	Seismic Design of Structures: Displacement Based	3		

	CIVE 422	Simulation of Construction Operations	3		
	CIVE 423	Assessment and Strengthening of Structures	3		
	CIVE 426	Building Construction Methods	3		
	CIVE 427	Construction Cost Management	3		
	CIVE 428	Construction Safety Management	3		
	CIVE 429	Construction Contracts Management	3		
	CIVE 430	Construction Equipment Management	3		
	CIVE 431	Civil Infrastructure Management	3		
	CIVE 432	Concrete Technology	3		
	CIVE 433	Earthquake Geotechnical Engineering	3		
	CIVE 436	Earthquake Design According to the IBC Code and Euro Code EC8	3		
	CIVE 438	Green Buildings and Sustainability	3		
	CIVE 444	Seismic Design of Foundations	3	CIVE 443	
	CIVE 451	Concrete Durability	3		
	CIVE 452	Cement Manufacturing and Hydration	3		
	CIVE 453	Concrete Materials for Sustainable Development	3		
	CIVE 504	Finite Element Analysis	3		
	CIVE 512	Pavement Design	3		CIVE 503
	CIVE 513	Traffic Engineering	3		
	CIVE 516	Advanced Geographic Information Systems	3	CIVE 323	
	CIVE 520	Principles of Environmental Engineering	3		
	CIVE 521	Wastewater Engineering Design	3	CIVE 520	
	CIVE 522	Water Resources and Water Quality	3		
	CIVE 523	Air Pollution Control	3		
	CIVE 524	Solid Waste Disposal	3		
	CIVE 525	Sanitary Landfill	3	CIVE 520	
	CIVE 526	Water Supply Engineering Design	3	CIVE 520	
	CIVE 527	Environmental Impact Assessment	3	CIVE 520	
	CIVE 528	Environmental Economics and Management	3	CIVE 520	
	CIVE 529	Environmental Chemistry	3		
	CIVE 530	Environmental Chemistry and Microbiology	3		

	CIVE 531	Environmental Sampling and Analysis	3		
	CIVE 532	Wastewater Treatment Plants: Processes, Design, and Operation	3		
	CIVE 540	Sustainable Roadway Design, Construction, and Operation	3		
	CIVE 541	Contemporary Cities	3		
	CIVE 542	Sustainable Development in Transportation Engineering	3		
	CIVE 543	Sustainable Development in Civil Engineering	3		
	CIVE 556	Bridge Design	3		
	CIVE 557	Advanced Structural Steel Design	3	CIVE 324	
	CIVE 558	Slope Stability and Embankment Design	3		
	CIVE 559	Pavement Reconstruction, Rehabilitation and Maintenance	3		
	CIVE 560	Transportation Management Systems	3		
	CIVE 561	Retaining Structures Design	3		
	CIVE 563	Advanced Soil Mechanics	3	CIVE 301	
	CIVE 564	Geosynthetics	3		
	CIVE 565	Soil-Structure Interaction	3		
	CIVE 566	Theory of Plates and Shells	3		
	CIVE 567	Physical Metallurgy of Steel	3		
Elective Lab (1 credit from the following list, or any 1-credit Lab approved by the Department):					
	CIVE 313	Transportation Engineering Modeling	1	CIVE 206	CIVE 308
	CIVE 315	Geotechnical Engineering Modeling	1		CIVE 307
	CIVE 318	Environmental Engineering Modeling	1		
	MECH 233	Workshop Technology	1		

COURSE DESCRIPTIONS

CIVE 201 STATICS **3.0: 3 cr. E**

Concept of forces, moments, and other vector quantities; analysis of force systems; conditions of equilibrium; analysis of simple structures; friction; centroids and moments of inertia; shear and bending moment diagrams.

CIVE 202 MECHANICS OF MATERIALS **3.0: 3 cr. E**

Fundamental stress and strain relationships, axial stress, safety factors, statically indeterminate axially loaded members, torsion, bending and shear stresses in beams, transformation of stress, combined stresses, deflections in beams, and analysis of columns.

Pre-requisite: CIVE 201

CIVE 203 ENGINEERING DRAWING I **0.3: 1 cr. E**

Concepts and practices in lettering, geometric construction, 2D multi-view and auxiliary projections, sections and connections, dimensioning, sketching wall sections, and perform architectural design. Emphasis on freehand sketching skills and learning AutoCAD (2D) basic drawing tools.

CIVE 204 CONSTRUCTION MATERIALS AND METHODS **3.0: 3 cr. E**

Physical and mechanical properties of construction materials; P/C concrete, asphalt, wood, ferrous metals, non-ferrous metals; proportioning of concrete mixes including admixtures with laboratory demonstrations. Finishing materials and methods.

Pre-requisite: CIVE 202

CIVE 205 THEORY OF STRUCTURES I **3.0: 3 cr. E**

Stress resultants (reactions, axial forces, shear forces, and bending moments) for beams and framed structures. Deflections of beams and frames by geometric methods (moment-area theorems and applications; conjugate beam analogy), and energy methods (virtual work method, Castigliano's theorems). Influence lines functions and their applications. Criteria for moving loads. Analysis of statically indeterminate beams and frames by force methods (consistent deformations) and displacement methods (slope deflection and moment distribution). Structural analysis with software application.

Pre-requisite: CIVE 202

CIVE 206 ENGINEERING DRAWING II **0.3: 1 cr. E**

The course aims at preparing the future civil engineer to meet the growing needs of the local specifications, and to be able to understand and create architectural drawings of residential buildings. Learning this course is based on the ability of using CAD packages (Auto CAD). The course seeks to develop the student effective utilization of computer aided drafting (CAD) skills, using AutoCAD to quickly create professional-quality 3D models.

Pre-requisite: CIVE 203

CIVE 208 SURVEYING **3.0: 2 cr. E**

The course consists of measuring and determining boundaries, areas, and location through traversing techniques. In addition, it includes providing the types of surveying, the methods of traversing and adjustment of errors, mathematical and physical concepts, coordinate systems, leveling, contour lines, mapping, horizontal and vertical curves.

Pre-requisite: MATH 200
Co-requisite: CIVE 214

CIVE 209 REINFORCED CONCRETE I **3.0: 3 cr. E**
Fundamentals of reinforced concrete behavior, analysis and design of rectangular beams, T- beams and one-way slabs including flexural and shear behavior, development and anchorage of reinforcement, deflections and crack control.

Pre-requisite: CIVE 205

CIVE 210 STRENGTH OF MATERIALS LABORATORY **0.3: 1 cr. E**
This course is designed to provide students with the basic properties, testing and inspection of common civil engineering materials that include mineral aggregates, cement, concrete, steel reinforcement and asphalt. Students will experience the way concrete is designed, mixed, compacted and tested according to international standards, and will gain a comparative knowledge of material properties and possible applications in construction. Written reports and oral presentation of experimental results are required.

Pre-requisite: CIVE 204
Co-requisite: CIVE 209

CIVE 214 SURVEYING LABORATORY **0.3: 1 cr. E**
Field application of concepts learned in class (CIVE 208) including basic measuring procedures for distances, elevations, angles, bearings, azimuth; theory of measurements and errors, mapping, construction and topographic surveys, traverses, adjustment and closure, area and volume computations.

Pre-requisite: CIVE 203
Co-requisite: CIVE 208

CIVE 243 FLUID MECHANICS LABORATORY **0.3: 1 cr. E**
Laboratory applications in fluid mechanics including fluid measurements and properties; flow in pipes; Reynolds number; rainfall hydrograph; forces on gates; orifices; weirs; open channel flow; and pumps.

Co-requisite: MECH 243

CIVE 290 INTRODUCTION TO THE ENGINEERING DESIGN PROCESS **0.3: 1 cr. E**
This course serves as a general introduction to the engineering profession, its main objectives, and concerns. It focuses on the engineering design process, its phases, challenges and constraints. Additionally, students are exposed to the qualities and attributes of a modern day engineer as expected by professional engineering societies, including integrity, professionalism, ethical commitment, environmental requirements, and leadership, as well as the role of the engineer in society. This course aims at setting students on the way to future design and professional work.

CIVE 301 SOIL MECHANICS **3.0: 3 cr. E**
Origin of soil and grain size, weight volume relationships and soil plasticity, engineering classification of soil, permeability and seepage, effective pressure concept, shear strength of soil, stress in a soil mass, soil consolidation settlement, lateral earth pressure (Retaining wall).

Co-requisite: CIVE 209

CIVE 303 COMPUTER-AIDED DESIGN **0.3: 1 cr. E**

Application of computers to analyzing common structures. Use of standard industry software packages (ETABS and SAFE) for analyzing two dimensional and three dimensional structures including trusses, moment resisting frames, and shear walls against gravity. Introduction of Local and Global Coordinates Systems, the importance of the proper connectivity among elements as well as the definition of the Cardinal points and the insertion points. Modeling of one-way and two-way slabs using different slabs types. Export of Structure Reactions from ETABS to SAFE and modeling of foundations.

Co-requisite: CIVE 304

CIVE 304 REINFORCED CONCRETE II **3.0: 3 cr. E**

Analysis and design of reinforced concrete structures and components: short columns subject to axial loads as well as axial load with uniaxial and biaxial bending, slender columns, beams subject to torsion, and two-way slabs (flat slabs and slabs with beams). Design according to the most recent edition of ACI-318M Code.

Pre-requisite: CIVE 209

CIVE 305 HEATING, VENTILATING AND AIR CONDITIONING (HVAC) **3.0: 3 cr. E**

Environmental comfort parameters. Heat transfer in building sections. Estimating heating, cooling and ventilation loads and the choice of appropriate systems. Design and layout of distribution ducts, pipes and outlets.

CIVE 306 SOIL MECHANICS LABORATORY **0.3: 1 cr. E**

In this course, students will perform several field and laboratory test methods that are commonly used to determine the mechanical properties of soils. These properties are crucial for the design of the foundation of each construction. The course includes determination of critical soils index, classification of soils, moisture-density relationship, California bearing ratio and hydraulic conductivity tests.

Co-requisite: CIVE 301

CIVE 307 SHALLOW FOUNDATION ANALYSIS AND DESIGN **3.0: 3 cr. E**

Analysis and design of shallow reinforced concrete footings: centrally loaded isolated footing, eccentrically loaded isolated footings, combined rectangular footing, combined trapezoidal footing, strap footing, mat foundation, retaining wall design.

Pre-requisites: CIVE 209, CIVE 301

CIVE 308 TRANSPORTATION ENGINEERING **3.0: 3 cr. E**

The role of transportation in society and the engineer's role in planning, design and operation of transportation systems; consideration of system constraints, costs and basic design criteria. Theory and practice in highway design according to AASHTO criteria; design of vertical and horizontal curves and cross-sections. Introduction to traffic elements including intersection design and analysis of roads and intersections level of service.

Pre-requisite: CIVE 208

CIVE 309 ENGINEERING ECONOMY **3.0: 3 cr. E**

The course introduces the student to the fundamental concepts of engineering economy covering time value of money; effective interest rate; economic worth analysis and evaluation of private construction projects, namely: net present value, future and annual worth, and internal rate of return; evaluation of

public projects, mainly benefit to cost ratio; replacement analysis: depreciation methods; break-even analysis: economic risk and after-tax cash flow.

Pre-requisite: MATH 200

CIVE 310 BUILDING LAWS **3.0: 2 cr. E**
The purpose of this course is to instruct the students to organize the building industry, and to enhance their knowledge of the Lebanese Building Laws in order to safeguard the environment, as well as private and public rights.

Pre-requisite: CIVE 203

CIVE 311 SANITARY ENGINEERING **3.0: 3 cr. E**
Sources and quantities of water supply and methods of collection, treatment and distribution. Quantities, treatment and disposal of wastewater. Quality parameters, criteria and international standards for drinking water and wastewater pollution control.

Pre-requisite: MECH 243

CIVE 312 CONSTRUCTION MANAGEMENT FUNDAMENTALS **3.0: 2 cr. E**
Civil Engineers working on sites as construction managers need to know the basics of construction management. Planning, scheduling and control are the three basic tools for construction managers. This course introduces the basic planning principles and procedures. It also expands on project deterministic project scheduling: mainly bar charts, network schedules AON, AOA and CPM. The course tackles the principles of cost estimation and also the quantity take-off and bar bending schedule estimation. This course introduces students to the leadership skills the construction manager must acquire.

Pre-requisites: CIVE 206, CIVE 209

CIVE 313 TRANSPORTATION ENGINEERING MODELING **0.3: 1 cr. E**
Highway design using professional commercial software integrating planning, geometric design including horizontal and vertical curves design, cross-sections with cut and fill calculations, and traffic modeling including traffic lights design and level of service. Results visualizations and assessment.

Pre-requisite: CIVE 206
Co-requisite: CIVE 308

CIVE 315 GEOTECHNICAL ENGINEERING MODELING **0.3: 1 cr. E**
Geotechnical analysis and design using commercial software PLAXIS including design of foundations and lateral earth retaining systems. Results visualizations and assessment.

Co-requisite: CIVE 307

CIVE 316 CONSTRUCTION MANAGEMENT MODELING **0.3:1 cr. E**
Use of commercial software for the operations, planning, budgeting, scheduling, resource allocation, resource leveling, and controlling construction projects.

Pre-requisite: CIVE 209
Co-requisite: CIVE 312

CIVE 318 ENVIRONMENTAL ENGINEERING MODELING 0.3:1 cr. E
Analysis and design using commercially available software: wastewater treatment plant; sizing of tanks; effluent concentration, results visualizations and assessment: cost analysis, operation and maintenance.

CIVE 319 REVIT FOR CIVIL ENGINEERS 3.0: 2 cr. E
The Autodesk Revit software is a Building Information Modeling (BIM) program that streamlines the design process through the use of a central 3D model, where changes made in one view update across all views and on the printable sheets. The first part of the course is designed to teach engineering students the Autodesk Revit functionality as they would work with it throughout the design process. Students begin by learning about the user interface and basic drawing, editing, and viewing tools; then learn design development tools including how to generate a structural model and interface with ETABS for analysis and design purposes. Finally, they learn the processes that take the model to the construction documentation phase. The second part of the course focuses specifically on the ability of the engineering students to design a well-coordinated project on Revit and then use the same Revit file for scheduling, management, quantity take-off, and planning either using the Revit software or by connecting the Revit file to different management software such as Primavera or MS Project.

Pre-requisite: CIVE 206

CIVE 320 STRUCTURAL DETAILING 3.0: 2 cr. E
A computer-aided drafting technique and drawings generation course using CAD programs. It includes generating drawings based on the conventions of engineering graphical communication with applications to different Civil Engineering areas of specialty. The course concentrates on the detailing and shop drawings preparation of Reinforced Concrete members according to ACI-315. A required project at the end of the course introduces the students to the preparation of execution drawings and consideration of production methods.

Pre-requisite: CIVE 206
Co-requisites: CIVE 304, CIVE 307

CIVE 321 ADVANCED COMPUTER AIDED DESIGN 3.0: 2 cr. E
Advanced modeling techniques using ETABS/SAFE Software packages. It consists of modeling in multiple grid systems using Cartesian and/or Polar coordinates, as well as non-concentric modeling with a variation in the Cardinal Points and Insertion Points; the use of Section Designer members and Non-Prismatic elements; all loading types and shapes in global and local coordinates; the ETABS concept for the Pattern Live Load; modeling of inclined slabs for stairs and ramps, and modeling of shells for all types of domes. Introduction to the ETABS overwrites for the design of Reinforced Concrete members (Seismic or Non-Seismic Design) using ACI318 Provisions. Introduction to temperature loads. Design of all types of Foundations using SAFE.

Pre-requisite: CIVE 303

CIVE 322 TECHNICAL PLATFORM COMPUTING FOR CIVIL ENGINEERING 3.0: 2 cr. E
This course develops computing skills using the technical computing platform Mathematica. Topics include: introduction to Mathematica, symbolic, numeric, graphics, animations, programming, document organization and typesetting. Applications to statics, dynamics, engineering mechanics, fluid mechanics and other engineering related courses. Emphasis on ability to plan solutions to technical problems then execute and prepare organized technical reports including tables, figures and illustrations.

Pre-requisite: CSIS 206

CIVE 323 INTRODUCTION TO GEOGRAPHIC INFORMATION SYSTEM 3.0: 2 cr. E
Basic theoretical and practical understanding of GIS concepts and technical issues and its application to the design and analysis of environmental engineering systems. The focus is a fundamental understanding of spatial data acquisition, civil and geo- processing, geo-statistical methods; visualization, and querying of spatial data; network modeling, terrain mapping, and spatial analysis. Students are trained through extensive computer lab sessions. The course will be based on the recently released ESRI ArcGIS 10.5.

Pre-requisites: CIVE 206, CIVE 208

CIVE 324 STRUCTURAL STEEL DESIGN 3.0: 3 cr. E
The primary objective of the course is to provide the student with solid background in the fundamentals of structural steel design. Steel will be used for typical civil engineering structures such as trusses, bridges, and framed structures. Structural design establishes the configuration, details and dimensions for standard AISC rolled shapes. The course addresses the design of simple individual structural elements (truss members, beams and columns in braced frames) and the design of simple connections of structural elements (welded and bolted).

Pre-requisite: CIVE 205

CIVE 389 SENIOR DESIGN I 3.0: 2 cr. E
In this course, first of two "Senior Design" courses, students shall work in multi-disciplinary teams to design a civil engineering project under the supervision of a Project Advisor. Projects will contain components of several civil engineering disciplines in order to integrate many elements of the curriculum. This includes some of the following: Structures, Geotechnical, Transportation, Topography, Sanitary, Hydrology and Water resources, Environmental, and/or Project Management. Each team shall define the project objectives and scope, locate relevant codes and identify related software packages, determine design specifications according to specific local and international standards, formulate a design criteria subject to constraints such as the impact on the local community and the environment, perform project/site analyses for possible alternate solutions, and finally present the preliminary design in the form of a written report and a verbal presentation.

Pre-requisite: CIVE 290, GENG 221, GENG 222
Co-requisite: CIVE 209

CIVE 390 SENIOR DESIGN II 3.0: 2 cr. E
This course is the second of two-course "Senior Design" sequence that comprises the final year capstone design experience. In this course students working as multi-disciplinary teams shall perform a complete integrated design of a civil engineering project, with all the parameters set forth in the CIVE389 course. Students shall practice team effort and develop communication skills, where each shall take a responsibility in a variety of roles and be able to combine all efforts to produce a final deliverable culminating design project with proper engineering professionalism and ethics. The project shall be presented to the department faculty on the "Projects Day" via a written report and a verbal presentation which include several deliverables such as: Calculations, Drawings, Computer models, Specifications, and/or any other considerations that contributed to the development and the success of the project.

Pre-requisite: CIVE 389

CIVE 401 THEORY OF STRUCTURES II 3.0: 3 cr. E
Approximate analysis of continuous beams, and frames. Parametric studies of some basic structures including towers, buildings, and bridges. Estimating deflections. Analysis of beam, truss, and frame

structures using the unit load method and the direct stiffness method. Influence lines of determinate and indeterminate continuous beams.

Pre-requisite: CIVE 205

CIVE 402 DYNAMICS OF STRUCTURES I **3.0: 3 cr. E**
Introduction to basics of dynamics: lumped mass dynamics with various loading functions. Response to general dynamic loading with and without damping; free vibration, harmonic, impulsive, and arbitrary excitations. Develop the dynamic equations of motion for the single degree of freedom system (SDF) and multi-degree of freedom systems (MDF). Response spectrum analysis. Modal analysis of linear systems.

Pre-requisite: CIVE 401

CIVE 403 DEEP FOUNDATIONS **3.0: 3 cr. E**
Fundamentals of geotechnics applied to design and analysis of deep soil structure systems, single pile, sheet pile, group of piles, laterally loaded piles, efficiency of group pile, settlement of pile, braced cut, reinforced earth structure.

Pre-requisite: CIVE 307

CIVE 404 HYDRAULICS **3.0: 3 cr. E**
The course consists of the design and analysis of water supply networks including transmission and distribution pipes, reservoirs, tanks, pumps and pump selection, using the conservation of mass, momentum, and energy equations; design and analysis of open channels including gradually varied flows, backwater computations, and water surface profiles using the Manning equation; design and analysis of box culverts with inlet and outlet control.

CIVE 405 PRESTRESSED CONCRETE **3.0: 3 cr. E**
Fundamentals of prestressed concrete behavior. Analysis and design of pre-tensioned and post tensioned reinforced concrete members. Prestressed concrete is used to construct light, durable, and economical structures by pre-compressing the concrete that has high compressive strength using high strength pre-stressing steel. Preloading the tensile zone of the structural concrete members results in a self-equilibrating system of internal stresses under expected loads.

Pre-requisite: CIVE 304

CIVE 409 HYDROLOGY **3.0: 3 cr. E**
The course consists of describing the hydrologic cycle, precipitation and the water budget equation, interception and depression storage, infiltration, evaporation, transpiration, stream flow, groundwater, probability and statistics with frequency of occurrence, hydrographs, routing, with hydrologic modeling.

CIVE 410 APPLIED HYDRAULICS **3.0: 3 cr. E**
The course consists of describing the complete design and construction process of storm water networks including ponds, sewerage networks, water supply networks, irrigation networks, box culverts, open ditches, and scour analysis for bridges over waterways, and understanding of the Navier-Stokes equations.

Pre-requisite: CIVE 404

CIVE 411 INTRODUCTION TO EARTHQUAKE ENGINEERING AND SEISMOLOGY 3.0: 3 cr. E
Earthquake engineering, deals with the effects of earthquakes on people and their environment and with methods reducing those effects. This course is designed to help understand the fundamental principles and practical methods of earthquake engineering. It introduces the basic concepts of seismology, earthquakes, and strong ground motion and introduces procedures of deterministic and probabilistic seismic hazard analysis.

CIVE 414 EARTHQUAKE LOSS ESTIMATIONS 3.0: 3 cr. E
In the last few decades, a dramatic increase in the losses caused by natural catastrophes has been observed worldwide. The reasons for the increased losses are manifold, though certainly include the increase of world population, the development of new "super-cities" (with population greater than 2 millions), many of which are located in zones of high seismic hazard, and the high vulnerability of modern societies and technologies, such as the built environment. This course deals with the treatment of exposure, hazard, and vulnerability in earthquake loss models for urban areas and the propagation of the uncertainties within such models. Various case study applications involving the state-of-the art in catastrophe loss assessment will be presented.

CIVE 420 CONSTRUCTION PROCESSES 3.0: 3 cr. E
This course provides an overview of various construction processes. It focuses on several specific construction methods and engineering fundamentals of underground and aboveground construction, especially earthmoving operations. It focuses on the earthmoving operations' equipment: shovels, backhoes, clamshells, draglines, loaders, dozers scrapers and compactors. Course concentrates on the productivity evaluation of the construction processes, both deterministic, and using the queuing theory.

CIVE 421 SEISMIC DESIGN OF STRUCTURES: DISPLACEMENT BASED 3.0: 3 cr. E
The approach is based on determination of the optimum structural strength to achieve a given performance limit state, related to a defined level of damage, under a specific level of seismic intensity. Fundamental of displacement-based design, seismic input for displacement based design, analytical tools for displacement based design. The course considers a wide range of structural types, including among other; frame buildings, wall buildings, dual wall / frame buildings.

CIVE 422 SIMULATION OF CONSTRUCTION OPERATIONS 3.0: 3 cr. E
This course provides an overview of the quantitative stochastic methods used for the design and analysis of construction operations, in order to maximize the productivity and resource utilization through discrete event simulation. The course provides an introduction to queuing theory, and then focuses on simulation for construction operation analysis. Specific emphasis is placed on modeling building construction, heavy and highway construction, and underground construction technologies. Micro-CYCLONE simulation languages are used for the design of the construction operations.

CIVE 423 ASSESSMENT AND STRENGTHENING OF STRUCTURES 3.0: 3 cr. E
Assessment of seismic vulnerability of classes of buildings: force-based and displacement-based methodologies. Typical response of individual buildings: capacity design concepts, analysis of well-designed buildings. Typical response of existing buildings: problems in analysis, damage and safety evaluation. Strength, deformation and dissipation capacity of elements and joints: flexural and shear problems, beam-column joints, infill panels. Assessment of global response: expected damage and failure modes, global strength, deformation and dissipation capacity, displacement based assessment methods. Strengthening of reinforced concrete buildings: modification of element and global response, redesign, safety re-evaluation.

CIVE 424 ADVANCED MECHANICS OF MATERIALS FOR CIVIL ENGINEERING 3.0: 3 cr. E
Concept of tensors of various degrees and dimensions using dynamics and the transformation of their components. Review of Mohr circle. Strain tensor, its properties and strain- displacement relations. Traction, stress tensor, their properties and stress equilibrium equations. Stress-strain relations for linear elastic materials and the role of symmetry. Overall formulation of small strain linear elasticity. Plane stress and plane strain with example solutions. Stress concentrations. Principle of virtual work and other derived, specialized principles. Torsion of non-circular cross-sections. Unsymmetrical bending. Stresses in thin-walled axisymmetric pressure vessels.

Pre-requisite: CIVE 202

CIVE 426 BUILDING CONSTRUCTION METHODS 3.0: 3 cr. E
New Construction methods in tunneling, excavations and buildings. Immersed, cut and cover, top down methods of tunneling construction. Tunnel boring, trenchless technology, vibroflotation, jet grouting and deep water drilling are explained. Different building methods are reviewed: underpinning of foundations, earthquake resisting systems and components, new and existing formwork technologies, tilt-up wall and lift slab construction, pneumatic wedge method of concrete dome construction, volumetric construction, 3-D printing of concrete and steel, tremie concrete and underwater construction, concrete canvas, foamcrete, thin joint mortar types, polyurea, smart bricks, rammed earth, drones and robots in construction, insulated concrete forms block, cellular light concrete block and other block types.

CIVE 427 CONSTRUCTION COST MANAGEMENT 3.0: 3 cr. E
This course focuses on (i) estimating different costs of projects, (ii) perform life cycle cost analysis for projects, (iii) study the different financing methods for both owners and contractors, (iv) understand cost control and monitoring of budgets, and (v) how to include costs in different contract types.

CIVE 428 CONSTRUCTION SAFETY MANAGEMENT 3.0: 3 cr. E
Identification of hazards and risks on construction sites; hazards evaluation; hazard control; fault tree analysis; crane, equipment, universal, access, construction, operation and maintenance hazards; and safety measures application.

CIVE 429 CONSTRUCTION CONTRACTS MANAGEMENT 3.0: 3 cr. E
Types of construction contracts; types of project delivery systems; different contract administration; contract accounting; and claims and disputes.

CIVE 430 CONSTRUCTION EQUIPMENT MANAGEMENT 3.0: 3 cr. E
The aim of this course is to train students in types of construction equipment management, mainly machine power estimation; equipment selection and utilization; equipment costs; and life cycle costs of equipment.

CIVE 431 CIVIL INFRASTRUCTURE MANAGEMENT 3.0: 3 cr. E
This course provides an overview of various civil infrastructure. It focuses on the main categories of civil infrastructure; condition assessment of different infrastructure (pipes, sewers, buildings, bridges, transit); deterioration methodologies (regression, Markov Chain, reliability); rehabilitation methods; optimization of maintenance; and budget allocation.

CIVE 432 CONCRETE TECHNOLOGY 3.0: 3 cr. E
Concrete components. Cementitious materials and chemical admixtures and their role in modifying concrete properties. Hot weather and cold weather concreting. High-performance concrete. Virtual cement and concrete testing laboratory. 3D concrete printing. A research project that gives students a wider exposure to Concrete Technology through their internet search is required.

CIVE 433 EARTHQUAKE GEOTECHNICAL ENGINEERING 3.0: 3 cr. E
The practice of geotechnical earthquake engineering principally involves the application of seismic analysis methodologies in the design and assessment of geotechnical structures. Analysis methodologies focus primarily on evaluation of site response and possible occurrence of liquefaction in modifying the seismic hazard at a site, and the consequences on the design of geotechnical structures such as shallow and deep foundations, slopes, embankments and earth retaining structures. The behavior of these structures under dynamic loading is also performed using the finite element software PLAXIS 2D.

CIVE 436 EARTHQUAKE DESIGN ACCORDING TO THE IBC CODE AND EURO CODE EC8 3.0: 3 cr. E
This course allows the students to design structures following the most recent codes in the United States known as the International Building Code (IBC) and in Europe known as the Euro code EC8.

CIVE 438 GREEN BUILDINGS AND SUSTAINABILITY 3.0: 3 cr. E
This course addresses the sustainability principles applied to site planning, building design, construction, operation, and management. It combines elements from various engineering disciplines and addresses the emerging trends in Leadership in Energy and Environmental Design (LEED) certification by US Green Building Council (USGBC).

CIVE 443 SEISMIC DESIGN OF REINFORCED CONCRETE BUILDINGS 3.0: 3 cr. E
Basic seismology, earthquake characteristics and effect of earthquakes on structures. Seismic base shear calculation using the (IBC-2012) and (UBC-1997). Earthquake resisting structural systems with plan and vertical irregularities. Design and detailing of seismic resistant reinforced concrete shear walls including boundary elements and coupling beams. Design and detailing of Moment Resisting Frames. All designs are based on the ACI-318M-14 (Ch 18) Seismic Provisions as well as the ACI-352 Beam-to-Column Connections. Recommendations.

CIVE 444 SEISMIC DESIGN OF FOUNDATIONS 3.0: 3 cr. E
This course concentrates on the modifications that foundations must be subjected to when they support structures designed for earthquakes forces. The detailing of the column-to-footing connections, shearwall-to-footing connections, and pile-to-pilecap connections according to ACI318M-14 Ch.18, are addressed. The effect of grade beams, tie beams and strap beams. Verification of punching shear under axial load and moment. The design of footings subjected to partial uplift. The seismic design of combined footings, strip footings, mat foundations and pilecaps using SAFE. Introduction to Base Isolation.

Pre-requisite: CIVE 443

CIVE 451 CONCRETE DURABILITY 3.0: 3 cr. E
Bases of durable concrete formulation. Early-age cracking control. The normative context regarding durability. Major durability problems: alkali–aggregate reaction in concrete, sulfate attack, steel corrosion, freeze–thaw. Durability issue in a marine environment. Consideration of durability in concrete structure design. Fire exposure.

CIVE 452 CEMENT MANUFACTURING AND HYDRATION 3.0: 3 cr. E
The main steps of cement manufacturing. The wet, dry, semi-dry and semi-wet process. Clinker burning and Cement grinding. Quality control and Bogue calculation. Portland cement hydration. Equilibrium curves. Nucleation and growth. Heat release during hydration. Portland cement hydrates. Set regulator. Green cement.

CIVE 453 CONCRETE MATERIALS FOR SUSTAINABLE DEVELOPMENT 3.0: 3 cr. E
Design for sustainability. Role of supplementary cementing materials in reducing greenhouse gas emissions. Recycling of demolished concrete and masonry. Glasscrete: Concrete with glass aggregate. Large-scale separation, treatment and value-added utilization of waste in concrete.

CIVE 454 CONCRETE TESTING AND REPAIR 3.0: 3 cr. E
This course familiarizes the students with the basis of inspections of concrete structures, destructive vs. non-destructive testing methods and the rehabilitation of concrete structures. Guidelines for conducting visual inspection of concrete in service are presented in this course along with several methods for assessing the strength of concrete structures. Assessment of characteristic in-situ compressive strength by testing of cores, indirect testing (Rebound hammer test, ultrasonic pulse velocity measurement and pull-out test) and others are described.

CIVE 456 FUNDAMENTALS OF ROAD CONSTRUCTION 3.0: 3 cr. E
This course covers an introduction to fundamental concepts in road materials and pavement construction including surface and sub-base layers. Flexible and rigid pavement construction are addressed in different stages: earthwork preparation, construction materials, drainage, surface preparation, and surface treatments. Students will be able to identify different test procedures to characterize bitumen binders and learn the method of the SUPERPAVE grading system. They will gain a working knowledge of soil/subbase behavior in addition to the geotechnical input needed for the design of road pavements.

CIVE 480 FIELD TRAINING 0.0: 3 cr. E
Prior to MS graduation, students are expected to undergo a two- to four-month training program at an institution whereby they get exposed and engaged in activities related to their field of studies, thereby gaining experience and demonstrating their skills.

CIVE 502 THEORY OF ELASTICITY 3.0: 3 cr. E
Introduction to basic elastic theory and its application to material structures. Definition of stress, strain, tensors, generalized Hooke's law, and field equations of elasticity. Equilibrium and compatibility conditions, and the formulation of boundary value problems. Application of the stress function method and the Green's function approach for 2D and 3D problems. Prediction of defects, internal forces and failure of simple solids and structural components. Solution of elasticity problems analytically.

CIVE 503 HIGHWAY DESIGN 3.0: 3 cr. E
The course provides a good understanding of terms and concepts that are used in highway engineering design such as location and geometric design, highway drainage, geotechnical, bituminous materials, design of flexible pavements, design of rigid pavements, operation and maintenance, noise pollution evaluation and control, and introduction to bridges. The course provides a thorough understanding of the role of highway engineering in society and the engineer's role in planning, design and operation of transportation systems, consideration of system constraints, cost, and basic design criteria.

Pre-requisite: CIVE 308

CIVE 504 FINITE ELEMENT ANALYSIS 2.1: 3 cr. E
This course presents finite element theory and methods for general linear and nonlinear analyses. Reliable and effective finite element procedures are discussed with their applications to the solution of general problems in structural applications. The governing continuum mechanic equations, conservation laws, and virtual work are used to establish effective finite element discretization. Furthermore, the stability, accuracy, and convergence of finite element modes are discussed. The general-purpose finite element analysis program ABAQUS is utilized to apply the theory and model structural sections.

CIVE 505 Dynamics of Structures II **3.0: 3 cr. E**

Formulation of the equations of motion for buildings with unsymmetrical plan and for continuous beams with multiple support excitations, construction of damping matrix, reduction of degrees of freedom by Rayleigh-Ritz Method, earthquake response of systems with distributed mass and elasticity, response history analysis (RHA) and response spectrum analysis (RSA) for multistory buildings, earthquake analysis and response of linearly elastic and inelastic buildings, earthquake dynamics of base isolated buildings.

Pre-requisite: CIVE 402

CIVE 507 BOUNDARY SURVEYS **3.0: 3 cr. E**

Land surveying, registration laws, history, survey systems, legal principles, boundary calculations, boundary descriptions, and evidence interpretation.

CIVE 512 PAVEMENT DESIGN **3.0: 3 cr. E**

The course on "Pavement Design" is designed to cover various theoretical and practical aspects of design of pavements. Different types of pavements commonly adopted for construction of low and high volume roads are introduced. The need for considering the structural and functional performance of pavements is explained. Various inputs required for design of new pavements such as climatic and traffic considerations, material characterization, analytical tools, etc. are discussed in detail. Different methods of analysis and design of bituminous and concrete pavements are discussed. Evaluation of in-service pavements and design of overlays for in-service pavements are covered in this course**.**

Co-requisite: CIVE 503

CIVE 513 TRAFFIC ENGINEERING **3.0: 3 cr. E**

This course aims at providing the student with a clear and thorough presentation of the theory and applications of Traffic Engineering. It aims at providing an understanding of the basic principles, and the ability to apply those principles. These include the traffic operations (characteristics of the driver, the pedestrian, the vehicle, and the road), traffic data collection (traffic terms and accidents) with application (traffic lights and interchanges, and level of service), and the transportation planning (the process, forecasting travel demand, evaluating transportation alternatives, and the transportation system management).

CIVE 516 ADVANCED GEOGRAPHIC INFORMATION SYSTEMS **3.0: 3 cr. E**

Geographic Information Systems (GIS) are important for Civil and Infrastructure Engineering works. This advanced GIS course discusses the ArcGIS Pro and ArcGIS Online and their applications in the planning and engineering fields, network creation and management, spatial planning applications, and implementation issues. The objective is to introduce core concepts of GIS and geospatial analysis, including coordinate systems, spatial data formats, and openly available geospatial data resources. Also, this course provides hands-on experience with an industry-standard GIS to perform practical tasks that include spatial analysis and extending core GIS functionality by using ArcGIS Online. The class includes a field data collection component to expose students to GIS data creation and Global Positioning Systems (GPS).

Pre-requisite: CIVE 323

CIVE 520 PRINCIPLES OF ENVIRONMENTAL ENGINEERING **3.0: 3 cr. E**

Man and environment. Sources of environmental pollution. Water pollution and its control. Principles of water and wastewater treatment. Air pollution and its control. Solid wastes and noise problems. Environmental Impact Assessment studies. Case studies.

CIVE 521 WASTEWATER ENGINEERING DESIGN .0: 3 cr. E
Sources and characteristics of wastewater. Collection works design. Theory and application of commonly used processes. Design of sludge treatment and disposal facilities. Process combinations to produce treatment systems. Case studies.

Pre-requisite: CIVE 520

CIVE 522 WATER RESOURCES AND WATER QUALITY 3.0: 3 cr. E
Water resources in Lebanon and around the world; Water resources regulation; Water resources usage issues; Water quality analysis and pollution control; Impacts of development on water resources and changes in water supply and availability; Water resources management.

CIVE 523 AIR POLLUTION CONTROL 3.0: 3 cr. E
Air Pollution Effects, Measurement and Control. The influence of man-caused pollution on the atmosphere, globally and locally. Evaluation of human health, economic, and aesthetic effects of air pollution. Techniques for measurement of atmosphere pollutant concentrations and determination of local and regional air quality. Detailed presentation of air pollution sources and methods for their control. The role of local, state and federal government in air pollution control.

CIVE 524 SOLID WASTE DISPOSAL 3.0: 3 cr. E
Generation of solid wastes. Onsite handling, storage and processing. Collection, transfer and transport of solid Wastes. Processing techniques and equipment. Recovery of resources, conversion products and energy. Disposal methods for solid wastes and residual matter: sanitary landfill, incineration, composting, and other techniques.

CIVE 525 SANITARY LANDFILL 3.0: 3 cr. E
Disposal of solid wastes on land. Effect of leachate on groundwater pollution. Theory and current practice regarding design, construction, and monitoring of sanitary landfill. Landfill operation and economic analysis.

Pre-requisite: CIVE 520

CIVE 526 WATER SUPPLY ENGINEERING DESIGN 3.0: 3 cr. E
Concepts in engineering, concepts in engineering design, concepts in branch design, phases of engineering designs, case studies. water characteristics, quality criteria and standards need for treatment, water treatment plant hydraulics and sludge disposal, storage and distribution system design, intake and transmission system design, computer applications for design, economic considerations in water supply engineering design.

Pre-requisite: CIVE 520

CIVE 527 ENVIRONMENTAL IMPACT ASSESSMENT 3.0: 3 cr. E
Concepts of environmental impact assessment. Planning and management of impact studies. Methods of impact identifications-matrices, network and checklists. Description of environmental setting. Environmental indices and indicators for describing the affected environment. Prediction and assessment of impacts on the air, soil, water, noise, visual, socioeconomic, biological and cultural environment. Decision methods for evaluation of alternatives. Public participation in environmental decision making. Case studies.

Pre-requisite: CIVE 520

CIVE 528 ENVIRONMENTAL ECONOMICS AND MANAGEMENT 3.0: 3 cr. E
Introduction to environmental economic problems; Modeling the Market Process and Failure. Conventional and Economic Solutions to environmental problems. Environmental decision making. Environmental risk analysis. benefits and costs assessment and analysis for environmental decision making. Case studies of major environmental problems and policy solutions.

Pre-requisite: CIVE 520

CIVE 529 ENVIRONMENTAL CHEMISTRY 3.0: 3 cr. E
Theory and practice of water chemistry. Principles of chemical kinetics and thermodynamics applied to fundamental understanding of aqueous environmental samples including natural waters, wastewaters, and treated waters; factors controlling chemical concentrations, acid-base equilibria, solubility equilibria, complex formation, electrochemistry, adsorption phenomena and corrosion.

CIVE 530 ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY 3.0: 3 cr. E
Chemistry of organic and inorganic contaminants in the environment. Natural chemical cycles in the biosphere, geosphere, hydrosphere and atmosphere, and consequences of anthropogenic disturbances. Chemical equilibrium and kinetics. Fundamentals of aquatic, atmospheric and soil chemistry. The fate of hazardous, refractory and heavy metal pollutants in the environment. Introduction to microbial taxonomy, ecology and growth kinetics of microorganisms. The microbes of public health importance in water, soil and air, including their detection, occurrence, transport, and survival in the environment. Introduction to the application of different processes to remove contaminants in natural and engineered systems.

CIVE 531 ENVIRONMENTAL SAMPLING AND ANALYSIS 3.0: 3 cr. E
Principles and methods for sampling and analysis of environmental tests such as surface water, groundwater, soil, air, and solid wastes. Physical, chemical, and biological laboratory methods for samples analyses. Sampling design for basic statistical concepts including data variability and detection of significant differences among sample sets. Data presentation and interpretation of data management methods. Off-campus lectures and demonstrations at laboratories.

CIVE 532 WASTEWATER TREATMENT PLANTS: PROCESSES, DESIGN, AND OPERATION 3.0:3cr. E
Well-designed and operated wastewater treatment plants are of tremendous benefit to municipalities, industries, public health, and the environment. This course combines engineering principles, practical know-how, and useful case studies to help you improve your knowledge of the wastewater treatment process. This course explains the various methods of the wastewater treatment process and the conditions where each method is implemented best.

CIVE 540 SUSTAINABLE ROADWAY DESIGN, CONSTRUCTION, AND OPERATION 3.0: 3 cr. E
Sustainable development is a concept that seeks to ensure that economic, environmental, and social, and cultural factors are central to the way development is taken forward to ensure the needs of society are addressed in both the present day, and in the longer term. In order for the concept of sustainable development to become embedded in national policy and legislation, the importance of sustainable development in relation to the design, operation, and construction of infrastructure has to be recognized and successfully applied. Integrating sustainable development into design enhances the performance of assets and infrastructure. The sustainable development of road projects can deliver sustainable benefits for the environment, the economy, and the society in general.

CIVE 541 CONTEMPORARY CITIES **3.0: 3 cr. E**

The "Contemporary Cities" course aims to prepare the students for the new themes of city development that are measured by new technologies and the "Urban Future". These themes are particularly related to the principles of "Sustainable Mobility" and the concept of "Smart Growth".

CIVE 542 SUSTAINABLE DEVELOPMENT IN TRANSPORTATION ENGINEERING 3.0: 3 cr. E

The course of "Sustainable Development in Transportation Engineering" aims to introduce the students to two interconnected general themes, "Sustainable Development" and "Transport Engineering", the latter being the branch of engineering that deals with the various modes of transport in their various aspects.

CIVE 543 SUSTAINABLE DEVELOPMENT IN CIVIL ENGINEERING **3.0: 3 cr. E**

This course aims at providing a broad overview of the current challenges of the civil engineering sector to accomplish the expected transition to sustainable development strategies. The course starts with an overview of the usual boundary conditions of every civil engineering project and shows a procedure to carry out multidisciplinary engineering projects: the engineering design process. Next, the materials – energy – carbon relationship is covered, providing a range overview of current global issues concerning the building industry and the use of materials. The units pursue to reflect a Life-Cycle thinking. As a result of this course, students ought to become more aware of global issues and to what extent civil engineering plays an important role on tackling them. The student shall develop a more holistic vision of infrastructures, considering the entire construction cycle and being aware of positive and negative economic, social, or environmental impacts of the different infrastructures. Terms such as the sustainable development goals (SDGs), resource management, embodied energy, resilience, life-cycle will after this course sound more familiar to students.

CIVE 555 SPECIAL TOPICS IN ENGINEERING **3.0: 3 cr. E**

Analysis and design of advanced concrete structures: stairways, reinforced concrete water tanks (rectangular and circular), concrete domes, corbels and deep beams, wind load provisions, walls, fiber polymer reinforcement, chimneys and minaret.

CIVE 556 BRIDGE DESIGN **3.0: 3 cr. E**

This course will focus on the fundamental behavior and design of reinforced and prestressed concrete bridge elements in the short and medium span range. Basic concepts of prestressing from the prestressed concrete course, commonly used methods and general design philosophy will be discussed. Service-load and ultimate-strength design of concrete bridge girders for flexure, shear and torsion effects will be studied, including serviceability constraints for control of deflection and cracking. Students will gain skills and competence in bridge design through practical design examples, presentations and a project assignment.

CIVE 557 ADVANCED STRUCTURAL STEEL DESIGN **3.0: 3 cr. E**

Introduction to plastic mechanism analysis; LRFD design of more complex structural components found in typical steel buildings; composite beams and columns, beam-to-column connections, column base plates, cover-plated beams, and built-up girders; computer applications to three-dimensional modeling techniques for steel structures; projects on structural analysis and design of trusses and frames to resist lateral wind and seismic loads.

Pre-requisite: CIVE 324

CIVE 558 SLOPE STABILITY AND EMBAKMENT DESIGN 3.0: 3 cr. E
This course is designed to provide the knowledge in groundwater seepage and contaminant transport in saturated and unsaturated soils. Flow nets for homogeneous and layered soils. Design and stability analysis of embankments and earth dams.

CIVE 559 PAVEMENT RECONSTRUCTION, REHABILITATION AND MAINTENANCE 3.0: 3 cr. E
This course is designed to provide techniques for reconstruction, rehabilitation and maintenance of flexible and rigid pavements including recycling, preventive maintenance, routine maintenance and soil stabilization design, and construction considerations.

CIVE 560 TRANSPORTATION MANAGEMENT SYSTEMS 3.0: 3 cr. E
This course is designed to provide the knowledge to conduct the project and network-level pavement management processes, to identify the data to be collected, and to define the conditions of the transportation system.

CIVE 561 RETAINING STRUCTURES DESIGN 3.0: 3 cr. E
Rigid and flexible earth retaining structures: rigid, anchored bulkhead, braced cut, tie-back cut, slurry trench and MSE (metallic and geosynthetic) walls with applications to infrastructure projects.

CIVE 562 DESIGN OF TIMBER STRUCTURES 3.0: 3 cr. E
This course is designed to provide the fundamentals of design of timber structures and application to simple structures.

CIVE 563 ADVANCED SOIL MECHANICS 3.0: 3 cr. E
This course is designed to provide a theoretical framework for the analysis of deformation and failure of soils with application to several practical problems. These include elasticity for linear deformation, plasticity models (including critical state model) for non-linear deformation and limit equilibrium analyses for important geotechnical problems.

Pre-requisite: CIVE 301

CIVE 564 GEOSYNTHETICS 3.0: 3 cr. E
Use of geosynthetics in civil and environmental engineering design for separation, reinforcement, and filtration, in slopes, embankments, roads, and foundations and for erosion control.

CIVE 565 SOIL-STRUCTURE INTERACTION 3.0: 3 cr. E
Interaction between ground and structure, exchange of mutual stress between structure and foundation ground, interface of the major structural elements within a structure and the foundation material, methods of analysis and modeling, beam on elastic foundations, effect of ground movement. Site response analysis, numerical modeling of complex engineering structures interacting with soil by taking into account an effect of nonlinear soil behavior, simple elasto-plastic models for soils, groundwater flow, consolidation and other rheological phenomena. Numerical Seismic analysis and modeling for underground structures, soil-structure interaction under extreme loading conditions including performance during earthquakes, floods, landslides, large deformations due to tunneling, deep excavations, and subsidence due to dewatering and cavernous rocks.

CIVE 566 THEORY OF PLATES AND SHELLS 3.0:3 cr. E
This course introduces students to basic theory of plates including stresses and deformations, bending of plates, energy solutions, small and large displacement theories, buckling and post-buckling of plates, and behavior of plates under shear. It also familiarizes students with the characteristics of shells, the

general theory of elastic shells, and membrane and bending theories for common shapes of axisymmetric structural shells. Additionally, analysis of plates and shells is performed using the finite element software ABAQUS.

CIVE 567 PHYSICAL METALLURGY OF STEEL 3.0: 3 cr. E

This course presents the students with the metallurgy of different metals/alloys including the heat treatments, phase transformations, and properties. This course familiarizes the students with common alloys such as: carbon steels, stainless steels, high-strength low alloys steels, heat treated steels, and advanced high strength steels. This course explains the effect of alloys addition on steel properties including martensitic quench and hardenability issues. This course describes the thermo-mechanical processing of alloys, the surface treatment and coating of steel products.

CIVE 568 MANAGEMENT OF CIVIL ENGINEERING SYSTEMS 3.0: 3 cr. E

This course introduces students to the different methodologies used in managing civil engineering systems. This course focuses on: i) Optimization methods, mainly Lagrange multipliers method, linear programming with graphical and simplex method, integer programming and network programming (shortest path, minimum spanning tree, maximum flow, minimum cost flow and transportation problems); ii) Queueing theory; iii) Decision trees; iv) Markov decision process; v) Reliability; and vi) Monte Carlo simulation.

FACULTY OF ENGINEERING GENERAL COURSES

ENVE 401 WATER RESOURCES ENGINEERING **3.0: 3 cr. E**

This course covers the principles of ground-water development. Techniques for analyzing rainfall, runoff, fluid flow, reservoir siting, aquifer and groundwater flows. Design of reservoirs, conduits, water distribution systems, well fields, transmission lines, sewers, and drains. Well pumps. Stresses in pipes; materials and design of pipes; Metallic corrosion. Storage and distributing reservoirs, construction and maintenance. Water supply system appurtenances and special structures. Population growth and its effects on water supply requirements.

GENG 221 ENGINEERING ETHICS **3.0: 3 cr. E**

This course introduces and reinforces the concepts, theories, and practice of engineering ethics and aims at providing basic knowledge of ethics for engineers in different types of work roles. It prepares the engineering students for identifying, taking responsibility for, and finding solutions to potential ethical problems/cases. It provides students with an interactive study of ethical theory and the development of professionalism and helps them think more clearly and deeply about ethical issues of the natures that engineers often face in professional practice, and explore resources, strategies, and options for dealing with such complications. Students review case studies of ethical conflicts in engineering practice. The course also covers engineering codes of ethics and requires students to resolve theoretical situations through the application of ethical codes.
(A core BS course as of 2023/24 to replace a CSPR XXX course for students who started from year 2022/2023. Previous students can take it as an equivalent of a CSPR XXX course if they have not already taken the required 3 CSPR XXX courses)

Pre-requisite: CHEN/CIVE/ELCP/MECH/290 (according to discipline), ENGL 203

GENG 222 SUSTAINABLE DEVELOPMENT FOR ENGINEERS **3.0: 3 cr. E**

This course introduces the fundamental and advanced concepts of sustainable development. It transitions students' understanding of the UN Sustainable Development Goals (SDGs) to focus specifically on the critical role of engineers in achieving these SDGs. Students should then be able to resolve problems by adopting sustainability principles, which should in turn reflect on the students' multidisciplinary design ability to ensure a proper sustainable design process to improve and preserve the quality of life for future generations.
(A core BS course as of 2023/24 to replace a CSPR XXX course for students who started from year 2022/2023. Previous students can take it as an equivalent of a CSPR XXX course if they have not already taken the required 3 CSPR XXX courses)

Pre-requisite: CHEN/CIVE/ELCP/MECH/290 (according to discipline), ENGL 203

GENG 311 ENGINEERING MANAGEMENT AND ECONOMICS **3.0: 3 cr. E**

Engineers with excellent managerial skills and superior economic acumen are needed as leader of the new century engineering world. This course prepares engineers to fulfill their managerial responsibilities and acquire useful economic perspectives. This course is organized to contain two major parts: (I) Functions of engineering management, and (II) Economic fundamentals for engineering managers. Part (I) introduces the basic functions on engineering management such as planning, organizing, leading and controlling, while part (II) covers the fundamentals of engineering economics.

GENG 400 ENGINEERING SEMINARS **2.0: 1 cr. E**

This module consists of lectures and seminars covering recent research and advances in various fields and applications of engineering disciplines.

GENG 402 PROJECT MANAGEMENT **3.0: 3 cr. E**

To make available the fundamentals of project management with the most workable types of organizations and the necessary capabilities that must be included to reasonably ensure success and minimize the possibility of failure. The course consists of construction contracting for contractors, owners, and engineers: bidding, industry structure, types of contracts, and delivery systems of construction, planning, estimating, quantity take-off and pricing, labor and equipment estimate, proposal preparation, contract documents to prepare detailed estimates, permits, risk management, and taxes. Basic critical path planning and scheduling with activity on nodes and activity on arrows, monitoring, updating, controlling, crashing, resource leveling, resource allocation, and least cost scheduling including time-cost trade-off analysis. Computer applications using the Primavera software.

GENG 490 GRADUATION PROJECT **3.X: 3 cr. E**

An approved final design project.

Refer to General Listing of Course Descriptions for:

BIOL XXX
Refer to Faculty of Arts and Sciences

CHEM XXX
Refer to Faculty of Arts and Sciences

CSIS XXX
Refer to the Faculty of Arts and Sciences

CSPR XXX
Refer to the Faculty of Arts and Sciences

ENGL XXX
Refer to the Faculty of Arts and Sciences

ENMG XXX
Refer to the Department of Engineering Management

EVSC XXX
Refer to the Faculty of Arts and Sciences

GENG XXX
Refer to the Faculty of Engineering Requirements

LISP XXX
Refer to the Faculty of Arts and Sciences

MATH XXX
Refer to the Faculty of Arts and Sciences

MECH XXX
Refer to the Department of Mechanical Engineering

MGMT 220, MRKT 456
Refer to the Faculty of Business and Management

PHYS XXX
Refer to the Faculty of Arts and Sciences