

Bachelor Degree in Civil Engineering

Two Tracks:

1. General Civil Engineering
2. Environmental Engineering

1. University Graduation Requirements

To receive a bachelor's degree in Civil Engineering, a student must fulfill all requirements related to credit hours, grade point average, program of study, and courses.

2. Degree Requirements

Type of Requirement	Credit Hours
University Requirements	30
College Requirements	37
Specialization Requirements	55
Specialization Electives	12
Total	134

3. University Requirements

➤ **University Requirements: 30 credit hours distributed as follows:**

Course ID	Course Title	Credit Hours	Prerequisite
ARAB 101	Basic Academic Arabic	3	
ARAB 201	Advanced Academic Arabic	3	ARAB 101
CSC 101	Introduction to Computing for engineers	3	
ENGL 101	Basic Academic English I	3	
ENGL 102	Basic Academic English II	3	ENGL 101
ENGL 203	Advanced Academic English I	3	ENGL 102
SOCS 101	Islamic Civilization I	3	
SOCS 202	World Civilization	3	
MATH 101	Calculus I	3	
	Free elective	3	
Total		30	

➤ **A Free Elective Course: 3 credit hours from the following list:**

Course Number	Course Title	Credit Hours	Prerequisite
FREN 101	Basic French I	3	
PHED 101	Physical Education I	3	
SOCS 201	Islamic Civilization II	3	SOCS 101
ASTR 150	Introduction to Astronomy	3	
CHEM 150	Chemistry & Society	3	

4. College Requirements

➤ College Requirements (37 credit hours):

Course ID	Course Title	Credits	Pre-/Co-requisites
CHEM 101	General Chemistry I	3	
CHEM 101L	General Chemistry Lab	1	CHEM 101
PHYS 101	General Physics I	3	
PHYS 102	General Physics II	3	PHYS 101
PHYS 103L	General Physics Lab	1	PHYS 102
CIVE 205	Engineering Drawing	1	CSC 101
ELEE 230	Programming for Engineers	3	CSC 101
ENGL 206	Technical Writing	3	ENGL 203
MATH 102	Calculus II	3	MATH 101
MATH 201	Calculus and Analytic Geometry III	3	MATH 102
MATH 202	Differential equations	3	MATH 201
MATH 215	Linear algebra and Numerical Techniques	3	MATH 202
STAT 230	Probability and Statistics	3	MATH 201
COEN 300	Engineering Economy	3	STAT 230
COEN 401	Engineering Ethics	1	ENGL 203
Total		37	

5. Program Specialization Requirements

Program specialization requirements consist of **67** credit hours: **55** compulsory credit hours, **12** elective credit distributed as follows.

➤ Compulsory Specialization Requirements (58 credit hours):

Course ID	Course Title	Credits	Pre-/Co-requisites
CIVE 215	Computer Aided Engineering Drawing (AutoCAD)	1	CIVE 205
CIVE 210	Statics	3	PHYS 101, Co-Math102
CIVE 211	Structural Mechanics	3	CIVE 210
CIVE 220	Engineering Materials	3	CHEM 101, CHEM 101L
CIVE 220L	Engineering Materials Lab	1	Co-CIVE 220
CIVE 240	Fluid Mechanics	3	CIVE 211, MATH 202
CIVE 240L	Fluid Lab	1	Co-CIVE 240
CIVE 250	Environmental Engineering	3	CHEM 101
CIVE 260	Surveying	2	MATH 101
CIVE 260L	Surveying Lab	1	Co-CIVE 260
CIVE 310	Structural Analysis I	3	CIVE 211, MATH 215
CIVE 320	Concrete I	3	CIVE 220L, CIVE 310
CIVE 330	Geotechnical Engineering	3	CIVE 240

Course ID	Course Title	Credits	Pre-/Co-requisites
CIVE 330L	Geotechnical Engineering Lab	1	Co-CIVE 330
CIVE 351	Water and Wastewater Treatment and Laboratory	3	CIVE 250 CIVE 240L
CIVE 360	Transportation Engineering	3	CIVE 260, STAT 230
CIVE 400	Summer Internship Training	1	Last Summer in Study
CIVE 412	Steel Design	3	CIVE 310
CIVE 430	Foundation Engineering	3	CIVE 330
CIVE 460	Highway Engineering	3	CIVE 360
CIVE 471	Quantity Surveying and Cost Estimation	2	COEN 300, CIVE 320, CIVE 330, ELEE 230
CIVE 472	Contracts and Specifications	2	COEN 401, Co-CIVE 471
CIVE 480	Construction Management	3	CIVE 472
CIVE 498	Final Year Project I	1	90 credits, ENGL 206
CIVE 499	Final Year Project II	3	CIVE 498
Total		55	

➤ **Elective Specialization Requirements (12 credit hours from the following):**

General Civil Engineering Track Electives

Course ID	Course Title	Credits	Prerequisite
CIVE 403	Special Topics in Civil Engineering	3	
CIVE 410	Structural Analysis II	3	CIVE 310
CIVE 411	Bridges	3	CIVE 310, CIVE 320
CIVE 412	Steel Design	3	CIVE 310
CIVE 420	Concrete II	3	CIVE 320
CIVE 421	Special Topics in Concrete	3	CIVE 420
CIVE 422	Pre-Stressed Concrete	3	CIVE 420
CIVE 423	Strength and Rehabilitation of Concrete Structural Systems	3	CIVE 320
CIVE 431	Applied Foundation Engineering	3	CIVE 430
CIVE 432	Environmental Geotechnics	3	CIVE 330
CIVE 433	Soil and Site Improvement	3	CIVE 330
CIVE 434	Geotechnical Earthquake Engineering	3	CIVE 330
CIVE 440	Hydraulics and Laboratory	3	CIVE 240
CIVE 441	Hydraulic Structures	3	CIVE 240
CIVE 442	Engineering Hydrology	3	CIVE 240
CIVE 443	Groundwater Hydrology	3	CIVE 240
CIVE 444	Hydraulics of Open Channels	3	CIVE 240
CIVE 445	Coastal Engineering	3	CIVE 240
CIVE 446	Transport Phenomena in Surface and Subsurface Waters	3	CIVE 240 CIVE 250

Course ID	Course Title	Credits	Prerequisite
CIVE 447	Water Resources Systems: Planning and Management	3	CIVE 351
CIVE 448	GIS for Water Resources & Environmental Engineering	3	CIVE 351
CIVE 450	Methods of Environmental Sampling and Analysis	3	CIVE 250
CIVE 451	Environmental Chemistry and Microbiology	3	CIVE 250
CIVE 452	Environmental Management and Decision Making	3	CIVE 250
CIVE 453	Water and Sewage Works Design	3	CIVE 351
CIVE 454	Solid Waste Management I	3	CIVE 351
CIVE 455	Solid Waste Management II	3	CIVE 454
CIVE 456	Air Pollution and Control	3	CIVE 250
CIVE 457	Industrial/Hazardous Waste Management	3	CIVE 451
CIVE 458	Environmental Impact Assessment	3	CIVE 250
CIVE 461	Pavement Design	3	CIVE 360
CIVE 462	Urban Transportation Planning I	3	CIVE 360
CIVE 463	Traffic Engineering	3	CIVE 360
CIVE 464	Transportation Systems Analysis	3	CIVE 360
CIVE 465	Design and Management of Transport Operations	3	CIVE 360
CIVE 466	Transportation Economics	3	CIVE 360 COEN 300
CIVE 470	Introduction to Geographic Information Systems	3	CIVE 260

➤ **Elective Specialization Requirements (12 credit hrs. from the following):**

Environmental Track Electives

Course ID	Course Title	Credits	Pre-/Co-requisites
CIVE 432	Environmental Geotechnics	3	CIVE 330
CIVE 448	GIS for Water Resources & Environmental Engineering	3	CIVE 351
CIVE 450	Methods of Environmental Sampling and Analysis	3	CIVE 250
CIVE 451	Environmental Chemistry and Microbiology	3	CIVE 250
CIVE 452	Environmental Management and Decision Making	3	CIVE 250
CIVE 454	Solid Waste Management I	3	CIVE 351
CIVE 455	Solid Waste Management II	3	CIVE 454
CIVE 456	Air Pollution and Control	3	CIVE 250
CIVE 457	Industrial/Hazardous Waste Management	3	CIVE 451
CIVE 458	Environmental Impact Assessment	3	CIVE 250
CIVE 459	Special Topics in Environmental Engineering	3	

Proposed Sequence of Study

Year I

➤ First Semester 18 Credit hours

Course	Title	Credits	Pre-requisites
ARAB 101	Basic Academic Arabic	3	
SOCS 101	Islamic Civilization I	3	
CSC 101	Introduction to Computing for Engineers	3	
ENGL 101	Basic Academic English I	3	
PHYS 101	General Physics I	3	
MATH 101	Calculus I	3	
Total		18	

➤ Second Semester 18 Credit hours

Course	Title	Credits	Pre-requisites
CHEM 101	General Chemistry I	3	
ENGL 102	Basic Academic English II	3	ENGL 101
MATH 102	Calculus II	3	MATH 101
PHYS 102	General Physics II	3	PHYS 101
ARAB 201	Advanced Academic Arabic	3	ARAB 101
ELEE 230	Programming for Engineers	3	CSC 101
Total		18	

Year II

➤ Third Semester 18 Credit hours

Course	Title	Credits	Pre-requisites
CHEM 101L	General Chemistry Lab	1	Co-CHEM 101
MATH 201	Calculus and Analytic Geometry III	3	MATH 102
STAT 230	Probability and Statistics	3	MATH 102
SOCS 202	World Civilization	3	
ENGL 203	Advanced Academic English I	3	ENGL 102
CIVE 210	Statics	3	PHYS 101, Co-Math 102
CIVE 260	Surveying	2	
Total		18	

➤ Fourth Semester 19 Credit hours

Course	Title	Credits	Pre-requisites
ENGL 206	English Technical Writing	3	ENGL 203
MATH 202	Differential equations	3	MATH 201
COEN 300	Engineering Economy	3	STAT 230
CIVE 211	Structural Mechanics	3	CIVE 210
CIVE 220	Engineering Materials	3	CHEM 101, CHEM 101L
CIVE 250	Environmental Engineering	3	CHEM 101
CIVE 260L	Surveying Lab	1	Co-CIVE 260
Total		19	

Year III

➤ *Fifth Semester* *18 Credit hours*

Course	Title	Credits	Pre-requisites
CIVE 205	Engineering Drawings	1	CSC 101
CIVE 220L	Engineering Materials Lab	1	Co-CIVE 220
CIVE 240	Fluid Mechanics	3	CIVE 210, MATH 202
CIVE 240L	Fluid Lab	1	Co-CIVE 240
MATH 215	Linear algebra and Numerical Techniques	3	MATH 202
	Free Elective	3	
CIVE 310	Structural Analysis I	3	CIVE 211, CO- MATH 215
CIVE 360	Transportation Engineering	3	CIVE 260 STAT 230
Total		18	

➤ *Sixth Semester* *16 Credit hours*

Course	Title	Credits	Pre-requisites
PHYS 103L	Physics Lab.	1	Co-PHYS 102
COEN 401	Communication skills and ethics	1	ENGL203
CIVE 215	Computer Aided Engineering Drawing	1	CIVE 205
CIVE 320	Concrete I	3	CIVE 220L, CIVE 310
CIVE 330	Geotechnical Engineering	3	CIVE 211
CIVE 330L	Geotechnical Engineering Lab	1	Co-CIVE 330
CIVE 351	Water and Wastewater Treatment and Lab	3	CIVE 250, CIVE 240L
CIVE 460	Highway Engineering	3	CIVE 360
Total		16	

➤ *Summer Semester* *1 Credit hour*

Course	Title	Credits	Pre-requisites
CIVE 400	Summer Internship Training	1	Last summer in study
Total		1	

Year IV

➤ *Seventh Semester* *14 Credit hours*

Course	Title	Credits	Pre-requisites
CIVE 412	Steel Design	3	CIVE 310
CIVE 471	Quantity Surveying and Cost Estimation	2	COEN 300, CIVE 320 CIVE 330, ELEE 230
CIVE 472	Contracts and Specifications	2	COEN 400, Co-CIVE 471
CIVE 498	Final Year Project I	1	ENGL 206, 90 credits
	Specialization Elective	3	
	Specialization Elective	3	
Total		14	

➤ Eighth Semester 12 Credit hours

Course	Title	Credits	Pre-requisites
CIVE 430	Foundation Engineering	3	CIVE 330
CIVE 480	Construction Management	3	CIVE 472
CIVE 499	Final Year Project II	3	CIVE 498
	Specialization Elective	3	
Total		12	

Total Program Credits 134*

Completion of Bachelor in Civil Engineering

Course Descriptions

1. Required Courses

CIVE 205 Engineering Drawing 1(0, 0, 2)

Drawing equipment, lettering, Geometric construction, sketching, dimensioning, orthographic projections, points, lines, areas and solids, principal and auxiliary views, skew lines, distances between points, lines and plane surfaces, piercing points, shadow, perspective, surface development, applications.
Prerequisite: CSC 101.

CIVE 210 Statics 3(3, 0, 0)

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, and moment diagrams of beams and simple frames; friction; center of gravity and centroid; area moment of inertia; computer applications.
Prerequisite: PHYS 101
Corequisite: MATH 102.

CIVE 211 Structural Mechanics 3(3, 0, 0)

A course on stresses, strains, and stress-strain relationship; tension and compression; torsion of circular bars; bending and shear stresses in beams; combined stresses; stress transformation and Mohr's circle.
Prerequisite: CIVE 210.

CIVE 215 Computer Aided Engineering Drawing 1(0, 0, 2)

Introduction to Computer Aided Drawing (AutoCAD) Software, Drawing limits, grid setting and drawing aids, coordinate system, Drawing tools (point, line , ray, multi-line, poly-line, polygons, rectangle, arc, circle, ellipse), Modify tools (copy, erase, offset, move, rotate, lengthen, terminate, fillet, chamfer, array), Layers, Zoom, dimensions, text, hatch, isometric drawing.
Prerequisite: CIVE 205.

CIVE 220 Engineering Materials 3(3, 0, 0)

This course introduces Civil Engineering materials that include cement, aggregates, admixtures, plain concrete, steel, masonry, plastics and polymers. Concrete mix design, concrete curing and durability; construction equipment and technologies; hot and cold weathering concreting.
Prerequisite: CHEM 101, CHEM 101L.

CIVE 220L Engineering Materials Lab 1(0, 0, 2)

Hands-on laboratory experiments to introduce students to testing different materials including cement, aggregates, admixtures, plain concrete, steel, masonry, and plastics.
Co-requisite: CIVE 220.

CIVE 240 Fluid Mechanics 3(3, 0, 0)

An introductory course on fluid behavior emphasizing conservation of mass, momentum, and energy and dimensional analysis; study of fluid motion in terms of the velocity field, fluid acceleration, the pressure field, and the viscous effects; applications of Bernoulli's equation, Navier- Stokes, and modeling; flow in ducts, potential flows, and boundary layer flows.
Prerequisite: MATH 202, CIVE 211.

CIVE 240L Fluid Lab 1(0, 0, 2)

Hydrostatic, Fluids in motion, Open channel flow, Uniform flow, Non-uniform flow, Flow through pipelines, Flow over weirs and under sluice gates, Hydraulic machinery, Water pumps, Flow water Measurement.
Co-requisite: CIVE 240.

CIVE 250 Environmental Engineering 3(3, 0, 0)

A course that introduces the fundamentals of environmental engineering. A screening course of major topics in environmental engineering including water and wastewater, environmental hydrology, environmental hydraulics and pneumatics, air, solid waste, noise, environmental modeling, and hazardous waste.

Prerequisite: CHEM 101.

CIVE 260 Surveying 2(1, 0, 2)

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.

Prerequisite: MATH 101.

CIVE 260L Surveying Lab 1(0, 0, 1)

Surveying lab covers the three basic surveying tools – the tape, level and transit/theodolite – along with proper field procedures for basic surveying which include taking field notes, taping and EDM, leveling, bearings and azimuths, topography, and mapping. In addition, more advanced tools such as Total Station is also introduced.

Co-requisite: CIVE 260.

CIVE 310 Structural Analysis I 3(3, 0, 0)

An introductory course covering stability and determinacy of structures; influence lines; deflection of beams and frames by double integration method, moment-area theorems, and conjugate beam; principle of virtual work and applications on beams, frames and trusses; introduction to indeterminate structures; approximate analysis of building frames.

Prerequisite: MATH 215, CIVE 211.

CIVE 320 Concrete I 3(3, 0, 0)

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; design of short, slender and bi-axially columns.

Prerequisite: CIVE 220L, CIVE 310.

CIVE 330 Geotechnical Engineering 3(3, 0, 0)

A course on engineering geology, soil classification and index properties; soil structure and moisture; compaction; seepage; effective stress concept; compressibility and consolidation; stress and settlement analysis; shear strength.

Prerequisite: CIVE 240.

CIVE 330L Geotechnical Engineering Lab 1(0, 0, 2)

Water content determination, liquid and plastic limits, shrinkage limit, grain size distribution (sieve analysis), hydrometer analysis, compaction, in-situ field density, constant and falling head permeability tests, unconfined compression test, tri-axial test, direct shear test.

Co-requisite: CIVE 330.

CIVE 351 Water and Wastewater Treatment and Laboratory 3(2, 0, 2)

A course that examines the quality and treatment methods of water and wastewater; testing for physical, chemical, and biological parameters.

Prerequisite: CIVE 240L, CIVE 250.

CIVE 360 Transportation Engineering 3(2, 0, 2)

A course that introduces the field of transportation engineering through a presentation of the basics of traffic engineering, traffic flow theory, and pavement design. A laboratory component consists of carefully structured experiments that reinforce students' understanding of the academic concepts and principles.

Prerequisite: STAT 230, CIVE 260.

CIVE 400 Internship for CE Students (1 Credit)

An eight- to twelve-week professional training course in Civil Engineering.

Prerequisite: Senior Standing, Last Summer in Study.

CIVE 430 Foundation Engineering 3(3, 0, 0)

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.

Prerequisite: CIVE 330.

CIVE 460 Highway Engineering 3(3, 0, 0)

A course that examines road vehicle performance; principles of geometric design and highways; horizontal and vertical alignment; earthwork; intersections and interchanges; parking facilities; basic traffic models; queuing theory and traffic analysis; travel demand forecasting.

Prerequisite: CIVE 360.

CIVE 471 Quantity Surveying and Cost Estimation 2(2, 0, 0)

Quantity surveying of earth, concrete reinforcing steel, electro-mechanical and finishing works; classification of costs; understanding the concepts of analogues, parametric and bottom-up detailed estimating techniques and applying those techniques in performing cost estimating of construction works with consideration to cost indexing, contingencies, and profits for determining unit rates and preparing final estimates and priced Bill of Quantities.

Prerequisite: COEN 300, CIVE 260, CIVE 320, CIVE 330

CIVE 472 Contracts and Specifications 2(2, 0, 0)

A course on the structure of contract documents, bidding requirements, general and detailed contract specifications, types of contracts, arbitration and legal requirements. Building structural specifications. Building finishing's specification.

Co-requisite: COEN 401, CIVE 471

CIVE 480 Construction Management 3(3, 0, 0)

A course on organizing for construction projects; pre-construction activities; bidding and contracts; fundamentals of construction planning, monitoring, and control; application of construction control tools: CPM, materials management, operations analysis, and quality control.

Co-requisite: CIVE 471, CIVE 472.

CIVE 498 Final Year Project I (1 Credit)

A chosen design topic of wide range of civil engineering application including structural, geotechnical, transportation, highway, material, hydrologic, water resources and environment and preparation of a detailed execution program for **CIVE 499**, through Define the project, State the objectives, Complete a literature survey, Set project specifications and master plan, Select a design method or experimental matrix.

Prerequisite: Senior Standing, ENGL 206, 90 credit hours.

CIVE 499 Final Year Project II (3 Credits)

A supervised project in groups of normally three students aimed at providing practical design experience in a civil engineering application.

Prerequisite: CIVE 498.

COEN 300 Engineering Economy 3(3, 0, 0)

A course that covers principles, basic concepts and methodology for making rational decisions in the design and implementation of real engineering projects; time value of money, depreciation, comparing alternatives, effect of taxes, inflation, capital financing and allocation, and decision under uncertainty.

Prerequisite: STAT 230.

COEN 401 Communication Skills and Ethics 1(1, 0, 0)

A course on engineering ethics covering responsibility in engineering; framing the moral problem; organizing principles of ethical theories; computers, individual morality, and social policy; honesty, integrity, and reliability; safety, risk, and liability in engineering; engineers as employees; engineers and the environment; international engineering professionalism; and future challenges.

Prerequisite: ENGL 203.

2. Elective Courses

➤ *Elective Courses - General*

CIVE 403 Special Topics in Civil Engineering **3(3, 0, 0)**

Any selected topic in the state-of-the-art in Civil Engineering.

Prerequisite: discretion of advisor.

CIVE 470 Introduction to Geographic Information Systems **3(3, 0, 0)**

An introductory course on Geographic Information Systems (GIS) and their applications in the planning and engineering fields, alternatives in computer-based graphics, data concepts and tools, network data management and planning applications, and implementation issues.

Prerequisite: CIVE 260

➤ *Elective Courses - Structural*

CIVE 410 Structural Analysis II **3(3, 0, 0)**

A course on the solution of statically indeterminate structures by flexibility (force) and stiffness methods for plane and space trusses and frames introduction to the direct stiffness method; influence lines for indeterminate structures; computer applications.

Prerequisite: CIVE 310.

CIVE 411 Bridges **3(3, 0, 0)**

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.

Prerequisites: CIVE 310 and CIVE 320.

CIVE 412 Steel Design **3(3, 0, 0)**

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, compression members, and beams.

Prerequisite: CIVE 310.

CIVE 420 Concrete II **3(3, 0, 0)**

A course that builds upon Concrete I and covers continuous beams; wall footings, concentrically and eccentrically loaded single column footings, and combined footings; staircases; bearing walls; cantilever retaining walls; two-way slabs.

Prerequisite: CIVE 320.

CIVE 421 Special Topics in Concrete **3(3, 0, 0)**

A course that reviews reinforced concrete design; wind load on structures; seismic design of structures; design of shear walls; brackets, corbels, and deep girders; torsion in concrete members; circular, rectangular, and elevated water tanks; spherical, conoidal, and ellipsoidal domes.

Prerequisite: CIVE 420.

CIVE 422 Pre-Stressed Concrete **3(3, 0, 0)**

A course on materials characteristics; prestress losses; working strength design procedures; composite construction; ultimate flexural strength and behavior; shear design; continuous pre-stressed concrete members.

Prerequisite: CIVE 420.

➤ *Elective Courses - Geotechnics*

CIVE 423 Strength and Rehabilitation of Concrete Structural Systems **3(3, 0, 0)**

A course on assessment of structural deficiency using analytical and field test methods; strengthening materials; strengthening of structural members in flexure, shear, and axial load; upgrading of gravity

load-designed members for earthquake load resistance.

Prerequisite: CIVE 320.

CIVE 431 Applied Foundation Engineering 3(3, 0, 0)

A course on braced excavations, retaining structures, deep foundations, slope stability, and computer applications.

Prerequisite: CIVE 330.

CIVE 432 Environmental Geotechnics 3(3, 0, 0)

A course on geotechnical practice in environmental protection and restoration; methods of soil and site characterization for sifting of waste repositories and site restoration; influence of physical and chemical processes in soils on the evaluation of contaminant distribution; design of waste containment systems including landfills, slurry walls, and soil stabilization; the applicability and use of geosynthetics; technologies for site restoration and cleanup.

Prerequisite: CIVE 330.

CIVE 433 Soil and Site Improvement 3(3, 0, 0)

A course that covers compaction, admixture stabilization, foundation soil treatment, reinforced soil and composite materials, and material sites reclamation.

Prerequisite: CIVE 330.

CIVE 434 Geotechnical Earthquake Engineering 3(3, 0, 0)

A course on causative mechanisms of earthquake, earthquake magnitudes, ground motion; influence of soil conditions on site response; seismic site response analysis; evaluation and modeling of dynamic soil properties; analysis of seismic soil-structure interaction; evaluation and mitigation of soil liquefaction and its consequences; seismic code provisions and practice; seismic earth pressures seismic slope stability and deformation analysis, seismic safety of dams and embankments, seismic performance of pile foundations, and additional current topics.

Prerequisite: CIVE 330.

➤ *Elective Courses - Transportation*

CIVE 461 Pavement Design 3(3, 0, 0)

A course examining 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.

Prerequisite: CIVE 360.

CIVE 462 Urban Transportation Planning I 3(3, 0, 0)

An introductory course on methods and models used in transportation planning with emphasis on the urban context.

Prerequisite: CIVE 360.

CIVE 463 Traffic Engineering 3(3, 0, 0)

A course outlining traffic engineering studies; traffic control of signalized and unsignalized intersections; signal control hardware and maintenance; arterial performance and operations; network optimization.

Prerequisite: CIVE 360.

CIVE 464 Transportation Systems Analysis 3(3, 0, 0)

A course on transportation and traffic problems in modern society. Among the topics covered are travel forecasting problems and methods; theoretical techniques for traffic flow description and management; highway, railway, and runway capacity and performance characteristics; economic considerations; cost functions.

Prerequisite: CIVE 360.

CIVE 465 Design and Management of Transport Operations 3(3, 0, 0)

A course that covers the application of quantitative techniques from operations research and probabilistic analysis to transportation problems. Applications covered include: pickup and delivery systems, emergency urban services, facility location, and network problems.

Prerequisite: CIVE 360.

CIVE 466 Transportation Economics **3(3, 0, 0)**
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 360 and COEN 300.

➤ *Elective Courses - Water Resources*

CIVE 440 Hydraulics and Laboratory **3(2, 0, 2)**
Flow in conduits, flow in open channels, flow measurements, and laboratory experiments.
Prerequisite: CIVE 240.

CIVE 441 Hydraulic Structures **3(3, 0, 0)**
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 240.

CIVE 442 Engineering Hydrology **3(3, 0, 0)**
Outlining hydrologic cycle; precipitation, evaporation, transpiration, and infiltration; rainfall-runoff analysis; stream flow measurement; hydrograph analysis; frequency analysis; flood routing; simulation models; urban hydrology; hydrologic design.
Prerequisite: CIVE 240.

CIVE 443 Groundwater Hydrology **3(3, 0, 0)**
A course that deals with properties of groundwater, groundwater movement, general flow equations, steady-state well hydraulics, seepage forces, unsteady well hydraulics, infiltration, and groundwater modeling.
Prerequisite: CIVE 340.

CIVE 444 Hydraulics of Open Channels **3(3, 0, 0)**
A course that examines gradually varied flow theory and analysis, spatially varied flow, and numerical modeling of unsteady flow in open-channels.
Prerequisite: CIVE 240.

CIVE 445 Coastal Engineering **3(3, 0, 0)**
A course on small-amplitude wave theory, finite-amplitude wave theory, conoidal waves, solitary wave theory, wave refraction, diffraction, and reflection, wave forces, and design of maritime structures (e.g., breakwaters).
Prerequisite: CIVE 240.

CIVE 446 Transport Phenomena in Surface and Subsurface Waters **3(3, 0, 0)**
A course on advection, diffusion, and dispersion of pollutants; transport in rivers and estuaries; transport in groundwater; numerical modeling; design of wastewater discharge system.
Prerequisite: CIVE 240 and CIVE 250.

CIVE 447 Water Resources Systems: Planning and Management **3(3, 0, 0)**
A course that introduces the main concepts and principles of water resources planning and management; logical steps in engineering planning and decision making; water resources systems analysis, modeling, simulation, and optimization; economic and financial analysis; flood protection and reservoir operation; and water resources management case studies.
Prerequisite: Senior Standing.

CIVE 448 GIS for Water Resources and Environmental Engineering **3(3, 0, 0)**
A course that introduces the concepts and principles of Geographic Information Systems (GIS) from the perspective of water resources and environmental engineering. It provides coverage of state-of-the-art GIS methods and tools, specifically targeting water resources and environmental applications including: spatial and terrain analysis, geo-statistical analysis, watershed delineation and identification of river networks, representation of groundwater and aquifer systems, time series analysis, and development of GIS integrated water and environmental models.
Prerequisite: CIVE 260.

➤ Elective Courses – Environmental**CIVE 450 Methods of Environmental Sampling and Analysis 3(3, 0, 0)**

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.

Prerequisite: CIVE 250.

CIVE 451 Environmental Chemistry and Microbiology 3(3, 0, 0)

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; biological water quality indicators.

Prerequisite: CIVE 250.

CIVE 452 Environmental Management and Decision Making 3(3, 0, 0)

A course that deals with mathematical programming techniques, multi-objective optimization, and the generation of alternatives, as these are used in environmental systems analysis and management; as well as introducing how considerations such as economics, uncertainty, equity, and other sociopolitical parameters may influence environmental management and decision-making.

Prerequisite: Senior Standing and CIVE 250.

CIVE 453 Water and Sewage Works Design 3(3, 0, 0)

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 351.

CIVE 454 Solid Waste Management I 3(3, 0, 0)

A course on nature and effects of solid wastes including hazardous wastes; engineering management principles, practices, and techniques for management of solid wastes administration; solid waste generation, storage, collection and transport, processing, resource recovery, and disposal; trip to a local facility.

Prerequisite: CIVE 351.

CIVE 455 Solid Waste Management II 3(3, 0, 0)

A course on the design of solid waste disposal schemes, including design reports and a literature search on the development of conventional treatment and disposal processes.

Prerequisite: CIVE 454.

CIVE 456 Air Pollution and Control 3(3, 0, 0)

An introductory course on air pollutants, sources, and effects; emissions estimates, regulations, and monitoring techniques; particulate matter characterization; meteorology and atmospheric dispersion; air pollution control processes.

Prerequisite: CIVE 250.

CIVE 457 Industrial/Hazardous Waste Management 3(3, 0, 0)

A course that deals with sources, quantity, and quality of industrial wastes; basic industrial waste treatment processes; major industries, types of wastes, and existing treatment practices; disposal and fate of industrial wastes.

Prerequisites: CIVE 451.

CIVE 458 Environmental Impact Assessment 3(3, 0, 0)

A course that outlines theories and procedures of assessing environmental impact; analysis of the impact of development on various measures of environmental quality; benefit-cost considerations in environmental impact assessment.

Prerequisite: CIVE 250.

CIVE 459 Special Topics in Environmental Engineering 3(3, 0, 0)

Any selected topic in the state-of-the-art in Environmental Engineering.

Prerequisite: discretion of advisor.