Civil, Environmental and Geomatics Engineering Graduate Courses

Civil Engineering Project Management (CCE 5036) 3 credits
This is a course in which planning, design, document preparation, bidding, big tabulation, construction management, cost estimation, conflict resolution and scheduling for civil engineering projects are covered. Students may not enroll in this course if they have completed CCE 4031.

Advanced Foundation Engineering (CEG 6105) 3 credits
Rigid and flexible earth retaining structures; shallow and deep foundations; laterally loaded piles; sheet-pile walls, braced excavations, cellular cofferdams, and buried culverts; consolidation settlement, stress distribution, elastic settlement, load bearing capacity; seepage and dewatering of foundation excavations. Students may not enroll in this course if they have completed CEG 4012.

Soil Stabilization and Geosynthetics (CEG 6124) 3 credits
Soil chemistry, mineralogy, and properties; techniques of soil reinforcement, soil improvement, and soil treatment; chemical stabilization; mechanical stabilization; designing with geosynthetics; foundations and pavement applications. Students may not enroll in this course if they have completed CEG 4122.

Pavement Analysis and Design (CEG 6129) 3 credits
Stresses and strains in flexible and rigid pavements, materials characterization, pavement performance, mechanistic design principles, AASHTO design method, pavement rehabilitation. Students may not enroll in this course if they have completed CEG 4126.

Terrestrial Laser Scanning (CEG 6304C) 3 credits
This course gives an introduction to applications of terrestrial laser scanning systems in geosciences, engineering, urban planning, forestry, architecture, emergency planning and forensics. Students may not enroll in this course if they have completed CCE 4514C.

Structural Health Monitoring (CES 5164) 3 credits
Prerequisite: CES 3102C with minimum grade of "C"
This course explores the theory and applications of structural health monitoring, which is a new technology to diagnose the state of structural conditions based on sensor data and novel data analytics approaches. This course covers various important topics, including sensing technology, signal processing, machine learning and optimization. Students are expected to gain a deep understanding of sensor-embedded structural maintenance systems and to learn how visualize and process sensor data.

Nonlinear Behavior of Structures (CES 5527) 3 credits
This course provides an introduction to the fundamental concepts used to analyze the

nonlinear behavior of structures under static loading conditions. Displacements, member forces and collapse conditions are studied considering equilibrium in the deformed configuration and linear-elastic, perfectly plastic material behavior. Assignments require the development of computer programs written in MATLAB (or Excel) and their solutions verified using nonlinear modeling capabilities of MASTAN2. Students may not enroll in this course if they have completed CES 4526.

Advanced Building Design (CES 5583) 3 credits
Prerequisite: CES 3102C
This course covers the fundamental concepts to determine the wind and seismic forces used in the design of buildings. Using the provisions of ASCE 7, wind and seismic force magnitudes, distributions and direction are determined for typical buildings. Wind forces are studied for the MWFRS and for components and cladding. Dynamic analysis of SDOF and MDOF building models are studied. Load transfer through the diaphragm to the lateral force resisting system is studied to determine member forces, drift and torsion. Students may not enroll in this course if they have completed CES 4225.

Advanced Structural Analysis (CES 6106) 3 credits
Review of matrix-force and displacement methods and their applications to civil structures.

Finite Element Methods in Civil Engineering (CES 6119) 3 credits
Variational principles, weighted residual methods, convergence criteria, shape functions for one-, two-, and three-dimensional elements, isoparametric elements, and applications to structural and geotechnical engineering. Students may not enroll in this course if they have completed EGM 5351.

Bridge Design (CES 6325) 3 credits
Planning, design, and construction of bridges. Discussion of bridge types and factors affecting the selection of type: concrete versus steel, prestressed, composite, segmental concrete bridges; design issues and techniques; detailed case study of a particular bridge; recent technological developments in bridge engineering.

Structural Dynamics (CES 6585) 3 credits
Response of lumped parameter systems to dynamic loading: formulation and solution of problems of one or more degrees of freedom for discrete systems, modal analysis, numerical integration, and transform techniques. Response of continuous systems. Introduction to earthquake engineering: response spectra, energy absorption capacity of structures, estimation of damping, seismic design, seismic codes, and soil-structure

interaction. Wind effects on structures and hurricane-resistant design. Blast-resistant design. Approximate design methods.

Advanced Steel Structures (CES 6607) 3 credits
Review of basic steel design; beam columns; interaction formulas; first-order and second-order moments; eccentric bolted and welded connections; moment resisting connections; composite construction; effective flange width; shear connectors; composite beams with formed steel deck; plate girder proportions; AISC requirements; flexure-shear interaction.

Advanced Reinforced Concrete (CES 6706) 3 credits
Analysis and design of two-way slabs, floor systems, deep beams, shear walls and footings. Limit state, yield line and deflection analysis. Continuity, tall buildings, seismic, and hurricane-resistant design. Torsion.

Prestressed Concrete (CES 6715) 3 credits
Behavior, analysis and design of pretensioned and post-tensioned concrete structures. Flexural, shear, bond and anchorage zone design. Partial prestressing strength, serviceability and structural efficiency of beams, slabs, tension and compression members. Frameworks and bridges.

Design and Analysis for Engineering Data (CGN 5716) 3 credits
Prerequisites: Basic course in statistics or permission of instructor
Course covers development of hypothesis and thesis-driven data analysis via applications of the basic principles of experimental design to analysis of engineering data, computational algorithms for sample size optimization, analysis of variance for experiments with a single factor, multi-variate analysis.

Special Topics in Civil Engineering (CGN 5935) 3 credits
Prerequisite: Permission of instructor
Study relating to specialized topics associated with civil engineering.

Graduate Seminar (CGN 5937) 0 credit
Prerequisite: Graduate standing
The objective is to encourage and enhance graduate student participation in technical seminars or presentations deemed appropriate by the department for graduate students. This course requires participation of graduate students in a minimum of five technical seminars or presentations in one semester. *Grading: S/U*

Infrastructure Maintenance and Management (CGN 6616) 3 credits
The course involves evaluating infrastructure systems (water, sewer, stormwater, roads, bridges, rail, power) to identify concepts on repair, replacement and maintenance, including dollars to spend on same.

Directed Independent Study (CGN 6905) 1-3 credits
Prerequisite: Permission of instructor
Study of topics in civil engineering relating to the special needs and interests of individual students.

Special Topics (CGN 6930) 1-3 credits
Prerequisite: Permission of instructor
Topics in civil engineering.

Master's Thesis (CGN 6971) 1-10 credits

Advanced Research (CGN 7978) 1-9 credits
Prerequisite: Permission of department
The course covers research that is relevant to the student's course of study in the Ph.D. program. This course requires oversight by the student's advisor who can assess the student's performance at the end of the semester. This course can be taken prior to admission to candidacy for the doctoral degree and may be repeated in multiple semesters. *Grading: S/U*

Dissertation - Transportation and Environmental Engineering (CGN 7980) 1-15 credits
Prerequisite: Permission of department
Grading: S/U

Stormwater Modeling and Management (CWR 5308) 3 credits
The course presents a comprehensive view of stormwater modeling and management with an emphasis on current modeling techniques and design practices. The course provides an in-depth review of fundamentals of hydrology along with spatial analysis tools required for effective stormwater modeling and management. Students may not enroll in this course if they have completed CWR 4307.

Groundwater Flow (CWR 6125) 3 credits
Infiltration; Capillarity; Groundwater and Aquifers; Anisotropy; Groundwater motion; Darcy's law, Dupuit-Forcheimer's law; Potential flow; Flow nets; Conformal mapping; Unsaturated flow; Diffusion and dispersion; Well hydraulics, Theis equation; Drainage; Salt water intrusion; Legal doctrines; Economics of groundwater.

Open-Channel Hydraulics (CWR 6235) 3 credits
Review of basic hydraulics: Continuity, momentum and energy balance; Uniform and steady flow; Non-uniform flow; Critical flow; Gradually-varied flow; Surface profiles; Chezy's and Manning's formulas; Laminar and turbulent flow; Velocity distribution; Unsteady flow; Rapidly varying flow; Flood routing; Design of open-channels.

Dynamic Hydrology (CWR 6525) 3 credits

Dynamics and statistics of principal hydrometeorological processes; Hydrologic cycle; Precipitation, Infiltration; Evapotranspiration; Surface runoff; Percolation; Groundwater motion; Storm water management; Hydrologic modeling; Water budget; Hydrologic time series, Stochastic analysis; ARARMA models.

Water Resource System Engineering (CWR 6818) 3 credits

Nature of water resource systems; Systems analysis, Objective functions; Optimal policy analysis; Linear programming; Dynamic programming; Political and economic objectives; Water resource subsystems; Deterministic and stochastic parameters; Large-scale, multi-objective projects; Water allocation; Supply and demand; Hierarchical modeling of water resource systems.

Modeling Methods in Water Resources and Environmental Engineering (EES 6025) 3 credits

Classification of PDEs; fundamentals of numerical analysis; numerical stability, consistency, and convergence; method of characteristics; variational principles; finite differences; finite elements; integral-boundary element method; applications to water resource and environmental engineering problems.

Energy Engineering (EGN 5735) 3 credits

This course provides an overview of renewable energy technology and outlines the basic principles of solar electricity, solar water heating, wind power, marine renewable energy, micro-hydro, biomass and heat pumps and their application in urban and rural environments. In addition, the fundamentals of conventional power generation (fossil fuel nuclear, etc.) are discussed.

Water and Wastewater Treatment (ENV 5510) 3 credits

Prerequisites: CWR 3201C or equivalent, ENV 3001C or equivalent, and permission of instructor

This course introduces students to the principles and design of physical, chemical and biological treatment systems for potable and wastewater applications. Students may not enroll in this course if they have completed ENV 4514.

Hydraulic Systems Engineering (ENV 5565C) 3 credits

This class outlines the concepts behind the design of piping and pumping stations. The class includes a review of hydraulics and piping networks, pipe materials, pump selection, multiple pump systems, sewer pumping networks and pump station design and appurtenances.

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Special Topics in Environmental Engineering (ENV 5935) 3 credits
Prerequisite: Permission of instructor
Study relating to specialized topics associated with environmental engineering.

Air Pollution and Control (ENV 6115) 3 credits
Review of air quality and air pollution problems. Sources, characteristics, and effects of specific air pollutants; Lower atmospheric motion dynamics; Dispersion and interaction of pollutants in the atmosphere; Smog effects; Air quality standards and regulations; Air pollution control methods; Acid rain. Students may not enroll in this course if they have completed ENV 4112.

Solid Waste Management (ENV 6356) 3 credits
Quantities and composition of refuse; Municipal and industrial solid waste disposal methods; Sanitary landfills; Incineration; Grinding and composting of refuse; Energy recovery from solid wastes; Hazardous waste; Optimization techniques to solid waste operation and management. Students may not enroll in this course if they have completed ENV 4341.

Water Supply and Treatment (ENV 6418) 3 credits
Bacteriological, chemical, and physical water quality standards; distribution systems; water treatment theory and design; aeration; coagulation and flocculation; sedimentation; filtration; disinfection; softening; membranes.

Contamination of Aquatic Sediment (ENV 6441) 3 credits
Prerequisites: ENV 3001C
Topics include: cohesive sediments, settling, re-suspension, aggregation, flocculation, pollutant adsorption/desorption; partitioning of chemicals, sediment toxicity assessment, bioassays/bioassessments, aquatic sediment sampling.

Wastewater Engineering (ENV 6507) 3 credits
Wastewater characterization, collection, and pumping. Physical unit operations and biological treatment unit process design including screening, sedimentation, filtration, activated sludge, disinfection, sludge digestion, and sludge disposal.

Environmental Systems and Processes (ENV 6668) 3 credits
Physical, chemical, and biological processes, reactor theory, particle transport, mass transfer, mixing, advection, dispersion, diffusion, sorption, phase transfer. Students may not enroll in this course if they have completed ENV 4053.

Sustainability and Pollution Prevention (ENV 6932) 3 credits
This course introduces students to the principles of engineering sustainability, life cycle cost analysis, pollution prevention and environmental resource management of

infrastructure planning and design. Students may not enroll in this course if they have completed ENV 4072.

Offshore Structures (EOC 6431) 3 credits
(See Ocean and Mechanical Engineering courses, this section)

Special Topics in Geomatics Engineering (SUR 5935) 3 credits
Prerequisite: Permission of instructor
Study relating to specialized topics associated with geomatics engineering.

Digital Photogrammetry and Image Interpretation (SUR 6335C) 3 credits
This course provides students with an advanced understanding of digital photogrammetric principles and their applications. This includes the techniques for calibration of digital cameras, extraction of point and linear features and 3D reconstruction of visible surfaces. The course also enables students to independently implement the digital photogrammetric concepts throughout projects, such as calibration of mobile phone camera and 3D surface reconstruction from stereoscopic images. Students may not enroll in this course if they have completed SUR 4331C.

Thermal Infrared Remote Sensing (SUR 6387C) 3 credits
Prerequisite: GIS 4035C with minimum grade of "C" or permission of instructor
Temperature is one of the most important physical variables. Temperature information with an appropriate spatial and temporal coverage is a key to addressing most of the environmental challenges on both local and regional scales. Measuring temperature remotely by thermal infrared is a new technology, which has found a wide area of applications. In this course, students learn the basic theory of sensors and data processing and analysis. They also investigate new applications of thermal infrared remote sensing on civil infrastructure and environmental systems monitoring. Students may not enroll in this course if they have completed SUR 4384.

Advanced Unmanned Aerial System Mapping (SUR 6402) 3 credits
Covers the fundamental components of small unmanned aerial systems (sUAS) and how they are used to produce high resolution, spatially accurate, planimetric maps and 3-D models of the terrain. Students may not enroll in this course if they have completed SUR 4503C.

Traffic Signal Systems (TTE 6259) 3 credits
This course teaches students about advanced concepts of traffic signal systems that are currently used in the U.S. Students design, evaluate and optimize various components of

traffic signal operations both for individual intersections and coordinated traffic signal systems.

Intelligent Transportation Systems (TTE 6272) 3 credits
Provides instruction on topics related to intelligent transportation systems, including theoretical fundamentals of systems engineering, traffic flow theory, architecture of telecommunications networks, freeway and arterial management and other topics related to ITS.

Transportation System Analysis (TTE 6501) 3 credits
Concepts of operations research using various models to optimize holistic operations of transportation systems from the perspectives of sustainability, resilience, environmental impacts and robustness are discussed. Programming model development and optimizations based on mathematical interpretations of descriptive problems are also covered.

Highway Traffic Characteristics and Measurements (TTE 6505) 3 credits
This course instructs students on the concept of advanced traffic operations including the characteristics of functional relationships between traffic modeling and travel demand forecasting. Students evaluate transportation scenarios and design solutions to improve traffic operations.

Transportation and Supply Chain Systems (TTE 6507) 3 credits
A study of engineering decision problems for transportation and supply chain systems, relying primarily on the quantitative methods of operations research. Topics include an introduction to the components of logistics systems, such as suppliers, customers, inventory, orders and freight transportation systems and the interactions between these components; a thorough coverage of models and solution techniques for the design and control of logistics systems, primarily network and network-based optimization models; and study in the application of such models and solution techniques.

Maritime Freight Operations (TTE 6508) 3 credits
Addresses important transportation modeling techniques for maritime freight transport. Mathematical models are used to represent transportation problems, and commercial computer software packages are used to evaluate and investigate modern freight transportation systems.

Sustainable Public Transportation (TTE 6651) 3 credits
Designed to outline the principles of transit systems in the urban transportation arena, functional relationships that govern bus and rail transit, and issues associated with

unbalanced flow and lane control, transportation system management and railroad economics and policies.

Highway Engineering (TTE 6815) 3 credits
Route selection including environmental impacts, vertical and horizontal alignment, intersection design, evaluation of subgraded soil strengths, and pavement design, drainage, and overlay design. Students may not enroll in this course if they have completed TTE 4810.