# CIVIL ENGINEERING (ECIV)

**ECIV 260. Surveying and Computer Graphics. 3 Units.**
Principles and practice of surveying; error analysis; topographic mapping; introduction to photogrammetry and Geographic Information Systems (GIS); fundamentals of computer-aided drafting using AutoCAD. Students will be instructed on effective communication of technical concepts and preparation of visual aids, including figures, tables, and slides. Laboratory. This course satisfies the GER Disciplinary Communication requirement only in combination with ECIV 368. Counts as a Disciplinary Communication course. Prereq: Declared BSE in Civil Engineering major, Civil Engineering minor, Environmental Engineering minor, or Requisites Not Met Permission.

**ECIV 300. Undergraduate Research. 1 - 3 Units.**
Research conducted under the supervision of a sponsoring Civil Engineering faculty member. Research can be done on an independent topic or as part of an established on-going research activity. The student will prepare a written report on the results of the research. Course may fulfill one technical elective requirement.

**ECIV 310. Strength of Materials. 3 Units.**
Mechanical properties of materials, deformations, stresses, strains and their transformation. Torsion of structural and machine elements, pressure vessels and beams under combined loading. Deflection and statically indeterminate beams. Energy methods and column stability. Prereq: ENGR 200.

**ECIV 311. Civil Engineering Materials. 3 Units.**
Steel, concrete, wood, masonry, and fiber-reinforced plastic. Experiments, advanced reading, and field trips. Strength, stiffness, ductility, and other properties of materials. Experiments on the flexural, compressive, and shear behavior of structural elements. Prereq: ECIV 310.

**ECIV 315. Introduction to Structural Engineering and Analysis. 3 Units.**
Introduction to the field of structural engineering and civil engineering structures. Calculation of structural loads for design. Static, linear, structural analysis of frame, truss, cable, and arch structures. Assessment of structural stability and determinacy. Introduction to strength limit state theorems and use of structural analysis software. Prereq: ENGR 200.

**ECIV 316. Matrix Analysis of Structures. 3 Units.**
Matrix formulation and computer analysis (MATLAB recommended) for statically indeterminate linear structural systems; Stiffness method (direct/displacement method); Potential Energy Method; Development of element equations for 1D axial and flexural members and 2D triangle element; Transformation between local to global coordinates; Development of displacement fields (linear function for axial members and cubic function for flexural members); Shape function concept in approximation; Introduction to elasticity, finite element analysis and nonlinear structural analysis. Additional term project on programming for six degrees of freedom beam structure analysis will be assigned to students enrolled in ECIV 416. Recommended for all students: Linear Algebra, Structural Analysis, and MATLAB Programing. Offered as ECIV 316 and ECIV 416. Prereq: ECIV 315.

**ECIV 330. Soil Mechanics. 4 Units.**
The physical, chemical, and mechanical properties of soils. Soil classification, capillarity, permeability, and flow nets. One dimensional consolidation, stress and settlement analysis. Shear strength, stability of cuts, and design of embankments, retaining walls and footings. Standard laboratory tests performed for the determination of the physical and mechanical properties of soils. Laboratory. Recommended preparation: ECIV 310.

**ECIV 340. Construction Management. 3 Units.**
Selected topics in construction management including specifications writing, contract documents, estimating, materials and labor, bidding procedures and scheduling techniques. The course is augmented by guest lecturers from local industries.

**ECIV 341. Construction Scheduling and Estimating. 3 Units.**
The focus is on scheduling, and estimating and bidding for public and private projects. This includes highways as well as industrial and building construction. The use of computers with the latest software in estimating materials, labor, equipment, overhead and profit is emphasized. Recommended preparation: ECIV 340 and consent of instructor.

**ECIV 342. BIM and Computer Graphics. 3 Units.**
This course is intended to apply Building Information Modeling tools in a meaningful manner within the AEC field. The course will progress through the core concepts of widely used VDC tools: AutoCAD, Sketchup, Revit, Navisworks. The key areas of focus will be conceptualizing projects, quantity takeoff, scheduling, and constructability review. Class time will involve hands-on training and exercises that will simulate real-world situations and deadlines. Complexity levels in the models will be minimized to ensure focus on concepts. Students will have multiple opportunities to hone their presentation skills with their projects through the course progression. Prereq: ECIV 260 and ECIV 340.

**ECIV 343. BIM Data Management & Remote Sensing. 3 Units.**
The course is intended to create awareness and advocacy for advanced design and planning technologies in the AEC industry, and integration into standard BIM platforms. The course will enhance competency in utilization of core BIM platforms for students with basic experience in Sketchup, Revit and Navisworks. Class time will involve hands-on exercises to simulate professional applications of technologies that improve accuracy and communication on projects. Technical equipment processes will be demonstrated in person, and situational challenges will be presented and assigned for course projects. Technology focus will include drones, LIDAR, and virtual reality simulations. Recommended Preparation: ECIV 341 & ECIV 342.

**ECIV 351. Engineering Hydraulics and Hydrology. 3 Units.**
Application of fluid statics and dynamics to Civil Engineering Design. Hydraulic machinery, pipe network analysis, thrust, hammer, open channel flow, sewer system design, culverts, flow gauging, retention/detention basin design. Applied hydrology, hydrograph analysis and hydraulic routing will also be introduced.

**ECIV 360. Civil Engineering Systems. 3 Units.**
Introduction to probability and statistics. Discrete and continuous random variables, probability distributions, bivariate data, probabilistic analysis of systems, and reliability analysis. Introduction to engineering economics. Interest rates and equivalence, present worth, rate of return analysis, depreciation, and inflation.

**ECIV 361. Water Resources Engineering. 3 Units.**
Water doctrine, probabilistic analysis of hydrologic data, common and rare event analysis, flood forecasting and control, reservoir design, hydrologic routing, synthetic streamflow generation, hydroelectric power, water resource quality, water resources planning. Recommended preparation: ECIV 351.

**ECIV 362. Solid and Hazardous Waste Management. 3 Units.**
Origin and characterization of solid and hazardous waste. Solid and hazardous waste regulations. Methods of solid and hazardous waste disposal. Waste management planning. Landfill siting and design considerations. Site Conceptual Models for remediation of contaminated sites. Technologies used for soil and groundwater remediation at solid and hazardous waste sites. Offered as ECIV 362 and ECIV 462.

**ECIV 363. Environmental Engineering Green Stormwater Infrastructure. 3 Units.**
This course will introduce students to the concepts of green infrastructure planning and design, impacts on the water cycle, water treatment mechanisms occurring within green infrastructure practices, regulatory drivers, and co-benefits and potential negative impacts on society or the environment. Students will examine case studies and develop concept plans for green infrastructure. Recommended Preparation: Basic Chemistry. Offered as ECIV 363 and ECIV 463.

**ECIV 368. Environmental Engineering. 3 Units.**
Principle and practice of environmental engineering. Water and waste water engineering unit operations and processes including related topics from industrial waste disposal, air pollution and environmental health. This course satisfies the GER Disciplinary Communication requirement only in combination with ECIV 260. Counts as a Disciplinary Communication course.

**ECIV 372. Timber and Masonry Design. 3 Units.**
Introduction to wood material. Design for timber beams and columns to resist vertical and lateral loads. Design of nailed and bolted connections. Introduction to masonry materials and design of wall. Offered as ECIV 372 and ECIV 472. Prereq: ECIV 315.

**ECIV 373. Reinforced Concrete Design. 3 Units.**
Use of ACI design methods for structural reinforced concrete members. Understanding of load combinations and load path in a typical concrete building structure. Analysis and design for flexure of singly reinforced & doubly reinforced sections, T-beams, one-way & two-way slabs, non-slender columns, and torsion members. Analysis and design for shear. Design for serviceability criteria and development of reinforcement. Prereq: ECIV 310 and ECIV 315.

**ECIV 374. Structural Steel Design. 3 Units.**
Use of the AISC specification for structural steel member design per the LRFD method. Understanding of gravity and lateral load paths in a typical steel building. Role of the Structural Engineer on a design team. Design of tension, compression and flexural members; design of combined bending/axial members; design of bolts and welds, connection elements, shear connections and moment resisting connections. Prereq: ECIV 310 and ECIV 315.

**ECIV 396. Civil Engineering Special Topics I. 1 - 3 Units.**
Special topics in civil engineering in which a regular course is not available. Conferences and report.

**ECIV 398. Civil Engineering Senior Project. 3 Units.**
Capstone course for civil engineering students. Material from previous and concurrent courses used to complete a multidisciplinary engineering design project. Professional engineering topics such as project management, engineering design, communications, and professional ethics. Requirements include periodic reporting of progress, plus a final oral presentation and written report. Counts as SAGES Senior Capstone. Counts as a SAGES Senior Capstone course.

**ECIV 400T. Graduate Teaching I. 0 Unit.**
This series of three courses will provide Ph.D. students with practical experience in teaching at the University level and will expose them to effective teaching methods. Each course assignment will be organized in coordination with the student's dissertation advisor and the department chairperson. Assignments will successively require more contact with students, with duties approaching the teaching requirements of a faculty member in the Ph.D. student's area of study. Prereq: Ph.D. students in Civil Engineering.

**ECIV 413. Theory of Elasticity and Plasticity. 3 Units.**
Matrix and tensor notations are used throughout the course. General analysis of strain and stress is presented, which includes principal and octahedral stresses and strains. The elastic stress-strain relations are introduced to formulate elasticity problems. The use of potentials to solve elasticity problems is introduced. The beam theory, including the torsion problem, is revisited and expanded. The problems of thick cylinders, disks, and spheres are presented. Energy principles and variational methods are discussed. The distortional energy is introduced. The phenomenology of plastic deformation is presented. The criteria for yielding under multiaxial stress states and the properties of the yield surface in the Haigh-Westergaard stress space are presented. Drucker's and Hill's postulates are derived. Flow rules and hardening rules are presented. The lower and upper bound theorems for limit analysis are introduced. Prereq: Graduate student standing or ECIV 310.

**ECIV 415. Fracture Mechanics and Size Effect. 3 Units.**
Linear Elastic Fracture Mechanics: crack tip fields, stress intensity factors, energy release rate, J-integral, fracture criteria. Nonlinear Theories: R-curve, plastic fracture mechanics. Quasibrittle Materials: cohesive crack models, fracture process zone. Fatigue cracks. Size Effect: linear elastic fracture mechanics prediction, size effect in quasibrittle materials. Experimental determination of fracture properties. Recommended preparation: ECIV 411. Prereq: ECIV 310.

**ECIV 416. Matrix Analysis of Structures. 3 Units.**
Matrix formulation and computer analysis (MATLAB recommended) for statically indeterminate linear structural systems; Stiffness method (direct/displacement method); Potential Energy Method; Development of element equations for 1D axial and flexural members and 2D triangle element; Transformation between local to global coordinates; Development of displacement fields (linear function for axial members and cubic function for flexural members); Shape function concept in approximation; Introduction to elasticity, finite element analysis and nonlinear structural analysis. Additional term project on programming for six degrees of freedom beam structure analysis will be assigned to students enrolled in ECIV 416. Recommended for all students: Linear Algebra, Structural Analysis, and MATLAB Programing. Offered as ECIV 316 and ECIV 416. Prereq: Graduate Student standing.

**ECIV 417. Structural Dynamics. 3 Units.**
Modeling of structures as single and multi-degree of freedom dynamic systems and their response to various forms of dynamic excitation. The eigenvalue problem, damping, and design for dynamic response. Analytical response calculation including modal, response spectrum, and time history methods. Introduction to finite element modeling of structures for dynamic properties and response calculation. Recommended Preparation: ECIV 316 or ECIV 416. Prereq: EMAE 181 or Graduate student standing.

**ECIV 418. Bridge Engineering. 3 Units.**
This course will introduce students to the general knowledge of bridge engineering including bridge design, bridge inspection, manuals and specifications, and design tools. Students will examine case studies and practice design examples. Recommended Preparation: ECIV 373 or ECIV 374, and ECIV 430.

**ECIV 419. Damage and Deterioration of Structures. 3 Units.**
This course introduces students to selected physical and chemical processes that cause damage to or deterioration of structural components. Topics to be covered include historical failures, excessive load and design/construction defects, moisture-related issues (for instance, corrosion, freeze-thaw, ASR/DEF, decay), fire-related issues (for example, strength loss, section loss), material compatibility (for instance, dissimilar metals, fire/preservation treatments), and ethics and client management. Steel, concrete, and wood components will be the primary focus of the course. Recommended Preparation: ECIV 372, ECIV 373, or ECIV 374.

**ECIV 420. Finite Element Analysis. 3 Units.**
Theory and application of the finite element method. Approximation theory as the basis for finite element methods. The formulations for a variety of finite elements in one, two, and three dimensions. The modeling and analysis of structural components and systems using planar, solid, and plate elements. Implementations of element formulations using Matlab. An advanced finite element analysis program will be used for analysis of structural problems. Recommended preparation: ECIV 316 is a prerequisite for structural engineering students. Background in advanced mechanics and numerical analysis of structures is required for this course. If you have not completed these courses, please discuss with the instructor. Prereq: Graduate Standing or ECIV 316.

**ECIV 426. Probabilistic Analysis. 3 Units.**
Introduction to probability and statistics. Uncertainty and decision analysis. Probability models for structural loads and strength. Probabilistic analysis of engineering systems. Estimation of the reliability of structures and infrastructure systems. Monte Carlo simulation. Recommended preparation: ECIV 360, introduction of probability and statistics, or equivalent.

**ECIV 427. Environmental Organic Chemistry. 3 Units.**
This is an advanced course focusing on examination of processes that effect the behavior and fate of anthropogenic organic contaminants in aquatic environments. The lectures will focus on intermolecular interactions and thermodynamic principles governing the kinetics of some of the important chemical and physicochemical transformation reactions of organic contaminants. Recommended Preparation: One semester of Organic chemistry or prior approval of the instructor.

**ECIV 430. Foundation Engineering. 3 Units.**
Subsoil exploration. Various types of foundations for structures, their design and settlement performance, including spread and combined footings, mats, piers, and piles. Design of sand-drain installations and earth-retaining structures including retaining walls, sheet piles, and cofferdams. Case studies. Recommended preparation: ECIV 330.

**ECIV 433. Soil Dynamics. 3 Units.**
I-DOF and M-DOF dynamics; wave propagation theory; dynamic soil properties. Foundation vibrations, design of machine foundations. Seismology; elastic and elastoplastic response spectra, philosophy of earthquake-resistant design. One and two-dimensional soil amplification, liquefaction, dynamic settlement. Soil-structure interaction during earthquakes. Recommended preparation: ECIV 330 and consent of instructor.

**ECIV 435. Elasticity and Data-driven Mechanics. 3 Units.**
This course consists of two parts. The first half of the course will cover the theory of elasticity and the fundamentals of the mechanics of continuous media, while the second half will focus on data-driven methods and machine learning techniques that can be utilized to discover the constitutive relations. Topics that will be covered include tensor calculus, stresses, balance principles, kinematics, constitutive laws, neural networks, constrained optimization, geometric learning, and symbolic regression. Prereq: (ENGR 200 and ECIV 310) or Graduate student standing.

**ECIV 437. Pavement Analysis and Design. 3 Units.**
Analysis and design of rigid and flexible airfield and highway pavements. Pavement evaluation and rehabilitations, overlay design. Recommended preparation: ECIV 330.

**ECIV 450. Environmental Engineering Chemistry. 3 Units.**
Fundamentals of inorganic, organic, and physical chemistry with emphasis on the types of problems encountered in the environmental engineering field. Equilibria among liquid, gaseous, and solid phases; kinetics to the extent that time permits. A strong mathematical approach is taken in solving the equilibrium and kinetic problems presented. Equilibrium speciation software for solution of more complex problems. Topics that will be covered in the course include chemical equilibrium, acid/base reactions, mathematical problem solving approach, graphical approaches, titration curves, solubility of gases and solids, buffering systems, numerical solution of equilibrium problems, thermodynamics, oxidation-reduction reactions, principles of quantitative chemistry and analytical techniques, introduction to the use of analytical instrumentation, and chemical kinetics. Prereq: ECIV 368 or requisites not met permission.

**ECIV 455. Data Analysis for Civil and Environmental Engineering. 3 Units.**
Comfort with manipulating and interpreting large datasets is increasingly important in many fields. This course will use examples grounded in civil and environmental engineering to cover topics essential for this, such as data cleaning, uncertainty, linear regressions, plotting, and machine learning. This is a programming intensive class (R will be the basis for instruction). Recommended preparation: ENGR 130 (or comfort with basic programming) and ECIV 360 (or other intro to probability/statistics course), or approval of instructor. Previous use of R is a plus, but not required.

**ECIV 456. Intelligent Infrastructure Systems. 3 Units.**
Topics on smart infrastructure systems; smart materials fabrication, embedded sensing technology for infrastructure condition monitoring, the system models for infrastructural condition diagnosing and adaptive controlling, and spatial-temporal integrated infrastructure management system.

**ECIV 461. Environmental Engineering Biotechnology. 3 Units.**
Process design fundamentals for biological reactors applied to environmental engineering processes, including wastewater treatment, bioremediation, and bioenergy production. Topics include mass balances, fixed-growth reactors, kinetics, microbial ecology, molecular biology and bioinformatics tools, and reactor models. Recommended preparation: ECIV 368.

**ECIV 462. Solid and Hazardous Waste Management. 3 Units.**
Origin and characterization of solid and hazardous waste. Solid and hazardous waste regulations. Methods of solid and hazardous waste disposal. Waste management planning. Landfill siting and design considerations. Site Conceptual Models for remediation of contaminated sites. Technologies used for soil and groundwater remediation at solid and hazardous waste sites. Offered as ECIV 362 and ECIV 462.

**ECIV 463. Environmental Engineering Green Stormwater Infrastructure. 3 Units.**
This course will introduce students to the concepts of green infrastructure planning and design, impacts on the water cycle, water treatment mechanisms occurring within green infrastructure practices, regulatory drivers, and co-benefits and potential negative impacts on society or the environment. Students will examine case studies and develop concept plans for green infrastructure. Recommended Preparation: Basic Chemistry. Offered as ECIV 363 and ECIV 463.

**ECIV 464. Environmental Hazard Mitigation of Nonpoint and Point Source Pollution. 3 Units.**
This course will expose students to principles, processes, and control of nonpoint/point source pollution. In this course, emphasis is placed on non-point source (NPS) problems associated with agricultural influences and the impacts of mining and forestry. In this course, students will be exposed to a variety of structural and non-structural management practices related to Environmental hazard on non-point and point source pollution.

**ECIV 472. Timber and Masonry Design. 3 Units.**
Introduction to wood material. Design for timber beams and columns to resist vertical and lateral loads. Design of nailed and bolted connections. Introduction to masonry materials and design of wall. Offered as ECIV 372 and ECIV 472.

**ECIV 473. Advanced Topics in Reinforced Concrete Design. 3 Units.**
This course aims to develop a clear understanding of advanced topics in reinforced concrete (RC) structural design. We aim to cover topics in the analysis and design of slender columns, deep beams, shear walls, two-way slabs, and RC members subject to torsion. Also, strut-and-tie models, design for earthquake resistance, and practical considerations in the RC design will be discussed. Students will practice their acquired knowledge and develop teamwork design experience through a term project. Prereq: Graduate Standing or ECIV 315 and ECIV 373.

**ECIV 474. Advanced Structural Steel Design. 3 Units.**
Advanced topics for the design of steel structures including member and frame stability, design of members for torsion, plate girders, base plate and anchorage connections, and basics of composite systems. Plastic analysis and design concepts for structural engineering limit state load applications. Seismic design of steel lateral force resisting systems. Prereq: ECIV 374.

**ECIV 476. Structural Fire Engineering. 3 Units.**
The Structural Fire Engineering course will discuss the analysis and design of structures subjected to fire. The course will cover the fundamentals of fire behavior, thermal boundary conditions, materials thermal properties, heat transfer, the effects of fire loading on mechanical material properties and structural systems, and structural analysis and design methods for fire resistance design of structures. Applications of advanced modeling and computational tools (such as ABAQUS) in structural fire engineering will be presented. Prereq: ECIV 315 or Graduate student standing.

**ECIV 500T. Graduate Teaching II. 0 Unit.**
This series of three courses will provide Ph.D. students with practical experience in teaching at the University level and will expose them to effective teaching methods. Each course assignment will be organized in coordination with the student's dissertation advisor and the department chairperson. Assignments will successively require more contact with students, with duties approaching the teaching requirements of a faculty member in the Ph.D. student's area of study. Prereq: Ph.D. student in Civil Engineering.

**ECIV 600T. Graduate Teaching III. 0 Unit.**
This series of three courses will provide Ph.D. students with practical experience in teaching at the University level and will expose them to effective teaching methods. Each course assignment will be organized in coordination with student's dissertation advisor and the department chairperson. Assignments will successively require more contact with students, with duties approaching the teaching requirements of a faculty member in the Ph.D. student's area of study. Prereq: Ph.D. students in Civil Engineering.

**ECIV 651. Thesis M.S.. 1 - 12 Units.**
Required for a Thesis-Focused Master's degree. Thesis work culminating in a written report and thesis examination. Prereq: Enrolled in ECIV Thesis-Focused M.S. Program.

**ECIV 660. Special Topics. 1 - 18 Units.**
Topics of special interest to students and faculty. Topics can be those covered in a regular course when the student cannot wait for the course to be offered.

**ECIV 695. Project M.S.. 1 - 9 Units.**
Required for a Project-Focused Master's degree. An engineering project approved by the chair of the department offering the degree. Prereq: Enrolled in ECIV Project-Focused or Course-Focused M.S. Program.

**ECIV 701. Dissertation Ph.D.. 1 - 9 Units.**
(Credit as arranged.) Prereq: Predoctoral research consent or advanced to Ph.D. candidacy milestone.