

# CIVIL AND ENVIRONMENTAL ENGINEERING

## Courses

### CIVE 2041 Civil and Environmental Engineering Seminar

**Prerequisites:** Sophomore standing or department permission required.

**Description:** An introduction to the importance of communication, professional ethics, knowledge of contemporary issues, and the role these play in developing a broad education. Emphasis will be placed on understanding the impact of engineering solutions in a global and societal context. The various sub-disciplines within the fields of Civil and Environmental Engineering will also be presented.

**Credit hours:** 1

**Contact hours:** Lecture: 1 Contact: 1

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

### CIVE 2081 Environmental Chemistry for Engineers

**Prerequisites:** CHEM 1414 with minimum grade of "C."

**Description:** This course applies the material covered in a general chemistry course for engineers to the skills needed for environmental engineering. In achieving these objectives, this course also supports Outcome 1 of the BSCE degree program accreditation requirements. (1) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

**Credit hours:** 1

**Contact hours:** Lecture: 1 Contact: 1

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

### CIVE 3413 Structural Analysis

**Prerequisites:** Minimum grade of "C" in ENSC 2143.

**Description:** Analysis of internal forces and deflections of structures subjected to static loading. Beams, trusses, and framed structures analyzed by appropriate classical methods. Classical methods and modern computer procedures for the analysis of statically indeterminate structures.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

### CIVE 3513 Structural Steel Design

**Prerequisites:** CIVE 3413 with minimum grade of C.

**Description:** Introduction to the design of structural steel members and connections in accordance with AISC specifications. May not be used for degree credit with ARCH 3323. May not be used for degree credit with CIVE 5473 and ARCH 3323.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 3 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

### CIVE 3523 Reinforced Concrete Design

**Prerequisites:** CIVE 3413 with minimum grade of C.

**Description:** Introduction to the design of reinforced concrete elements in accordance with the strength design requirements of the ACI Building code. May not be used for degree credit with ARCH 4123.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 3 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

### CIVE 3614 Engineering Surveying

**Prerequisites:** Minimum grade of "C" required in MATH 2123 or MATH 2144.

**Description:** Principles and techniques of vertical and horizontal measurements related to engineering and construction projects. Linear and angular measurements, differential leveling, traverses, topographic surveys, construction surveying, horizontal and vertical curves, earthwork quantities and design of route systems.

**Credit hours:** 4

**Contact hours:** Lecture: 3 Lab: 3 Contact: 6

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

### CIVE 3623 Engineering Materials Laboratory

**Prerequisites:** ENSC 2143 with minimum grade of "C."

**Description:** Introduction on material properties and related design criteria for common construction materials: structural steel, wood and timber, aggregates, portland cement and concrete, asphalt binder and concrete. Discussion on material specific topics on fabrication methods; mechanical and non-mechanical properties; use and applications; standards, testing and quality control measures; selection and design criteria. Laboratory exercises supplement lecture theory and provide "hands-on" experience in performing standard tests.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

### CIVE 3633 Transportation Engineering

**Prerequisites:** CIVE 3614 with minimum grade of "C", and minimum grade of "C" in STAT 4073 or STAT 4033 or concurrent enrollment.

**Description:** Planning, design and operations of transportation facilities. Vehicle characteristics and human factors in design. Traffic stream variables and their measurement techniques. Basic traffic flow models. Highway and street intersection capacity and level of service. Traffic control concepts. Transportation systems management. Application of statistical analysis and operations research to analyze transportation problems.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 3714 Introduction to Geotechnical Engineering**

**Prerequisites:** Minimum grade of "C" in ENSC 2143, or department permission required.

**Description:** Physical and mechanical properties of soils, including grain size analysis, plasticity, permeability, consolidation, and shear strength. Use of physical and mechanical properties to calculate stresses in a soil mass, lateral earth pressures and bearing capacity. Laboratory tests conducted to determine the physical and mechanical soil properties needed for application in geotechnical design. Course previously offered as CIVE 3713.

**Credit hours:** 4

**Contact hours:** Lecture: 3 Lab: 2 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

**CIVE 3813 Environmental Engineering Science**

**Prerequisites:** Minimum grade of "C" in (CHEM 1414 or CHEM 1515) and ENSC 3233.

**Description:** Engineering aspects of the life support system; the carbon-oxygen cycle; cycling of nitrogen, sulfur and phosphorus; and the hydrologic cycle. Concepts of environmental pollution and degradation. Techniques for mitigation; water and wastewater treatment, solid and hazardous waste management, and air pollution abatement. Calculation of pollution potential and treatment system parameters.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 3833 Applied Hydraulics**

**Prerequisites:** Minimum grade of "C" in ENSC 3233, and (CHEM 1414 or CHEM 1515).

**Description:** Basic hydraulic principles and their application in civil engineering problems. Analyses of water distribution networks, open channels, storm-water management and wastewater collection systems, water pumps, hydraulic models, hydraulic measurements, treatment plant hydraulics and hydraulic structures.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 3843 Hydrology I**

**Prerequisites:** Minimum grade of "C" in ENSC 3233 and (CHEM 1414 or CHEM 1515), and minimum grade of "C" in STAT 4033 or STAT 4073.

**Description:** Basic principles of surface groundwater hydrology and their application in engineering problems. The hydrologic cycle, weather and hydrology, precipitation, evaporation, transpiration, subsurface waters, stream flow hydrographs, hydrologic and hydraulic stream routing, probability of hydrologic events, application of hydrologic models. May not be used for degree credit with BAE 4314.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 3853 Environmental Engineering Laboratory**

**Prerequisites:** CIVE 3813 with minimum grade of "C".

**Description:** Performance of experiments with benchscale environmental engineering unit operations, review of chemical principles and analyses important to the evaluation of these and other environmental engineering applications. Emphasis on the development of experimental results that can be used in the design of full-scale units. May not be used for degree credit with CIVE 5813.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 3 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

**CIVE 4010 Civil Engineering Research**

**Prerequisites:** Senior standing or consent of instructor.

**Description:** Research and investigation of civil engineering problems. Offered for variable credit, 1-4 credit hours, maximum of 12 credit hours.

**Credit hours:** 1-4

**Contact hours:** Contact: 1-4 Other: 1-4

**Levels:** Undergraduate

**Schedule types:** Independent Study

**Department/School:** Civil & Environ. Eng

**CIVE 4013 Aquatic Chemistry**

**Prerequisites:** Senior standing and minimum grade of "C" in CHEM 1414 or CHEM 1515, and minimum grade of "C" in CIVE 3813.

**Description:** Application of chemical principles to environmental problems. Chemical kinetics, chemical equilibrium, acid-base chemistry, development of pc-pH diagrams, and coordination chemistry. Precipitation and dissolution reactions and oxidation-reduction reactions. Course is a senior elective. May not be used for degree credit with CIVE 5013.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4033 GIS Applications for Water Resources**

**Prerequisites:** Senior standing.

**Description:** Application of theoretical and practical components of geographic information system for engineers. Digital mapping of water resources information, spatial coordinate systems and digital terrain analysis using digital elevation models. Analysis of a variety of spatial data in efficient and effective manner. Introduction of geospatial analytical algorithms to solve civil and environmental problems. Course is a senior elective. May not be used for degree credit with CIVE 5033.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4041 Engineering Practice****Prerequisites:** Senior standing.**Description:** Topics relevant to the professional practice of civil and environmental engineering will be introduced, to include management principles, project management, and the laws that impact the practice of engineering, such as OSHA and ADA. Emphasis will be placed on written communication skills to include resumes, letters of introduction, and job interviews. The advantages of professional registration and technical/ professional society membership will be presented as well as discussions of professional ethics, income taxes and investments. Course previously offered as CIVE 4042.**Credit hours:** 1**Contact hours:** Lecture: 1 Contact: 1**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Civil & Environ. Eng**CIVE 4043 Senior Design****Prerequisites:** Minimum grades of "C" in each: CIVE 3623 and CIVE 3633 and CIVE 3714 and CIVE 3833; and within last two semesters of program completion. Minimum grade of "C" in CIVE 3513 or CIVE 3523.**Description:** Major comprehensive design experience using the team approach. Industry practitioners provide design projects and analyze and critique results. Extends the undergraduate experience and provides the student with opportunities to analyze and design complex structures. Capstone course. May not be used for degree credit with CIVE 4143.**Credit hours:** 3**Contact hours:** Lecture: 2 Lab: 2 Contact: 4**Levels:** Undergraduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Civil & Environ. Eng**CIVE 4050 Special Topics in Civil & Environmental Engineering****Prerequisites:** Senior standing and within last 2 semesters of program completion.**Description:** New courses offered in CIVE that have yet to be assigned a permanent number. Offered for variable credit, 1-4 credit hours, maximum of 8 credit hours.**Credit hours:** 1-4**Contact hours:** Contact: 1-4 Other: 1-4**Levels:** Undergraduate**Schedule types:** Independent Study**Department/School:** Civil & Environ. Eng**CIVE 4053 Transportation Geotechnics****Prerequisites:** CIVE 3714 minimum grade of "C".**Description:** This course focuses on the application of geotechnical engineering concepts to the analysis, design, and construction of transportation infrastructure. Topics covered include: soil classification systems, soil variability; subgrade evaluation procedures, repeated loading behavior of soils; soil compaction and field control; and subgrade stability for transportation facility engineering. May not be used for degree credit with CIVE 5053.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Civil & Environ. Eng**CIVE 4063 Introduction to Railroad Engineering****Prerequisites:** Senior standing and CIVE 3633 with minimum grade of "C".**Description:** This course provides civil engineering students a technical transportation course in Railroad Engineering. It covers a wide spectrum of railway engineering, including the basic principles, railroad design, construction, operation, evaluation and maintenance of rail infrastructure and networks. The students are expected to develop small group skills through team homework assignments and class interaction. May not be used for degree credit with CIVE 5063.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Civil & Environ. Eng**CIVE 4083 Applied Statistics for Civil Engineers****Prerequisites:** Senior standing, and CIVE 3633 with minimum grade of "C," and STAT 4033 or STAT 4073 with minimum grade of "C."**Description:** This course covers subjects including statistical fundamentals; continuous, count, discrete dependent variable models, random parameter models, and Bayesian modeling that are widely used in civil, particularly transportation engineering. Course is a senior elective. May not be used for degree credit with CIVE 5083.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Civil & Environ. Eng**CIVE 4093 Transportation Safety and Analysis****Prerequisites:** Senior standing and CIVE 3633 with minimum grade of "C".**Description:** This course introduces fundamental concepts for performing traffic safety analyses, including safety management systems, different safety countermeasures, development of statistical models with countermeasures and their effectiveness, economic analyses, and crash investigation. Students should be prepared to apply these important safety concepts in professional practice. May not be used for degree credit with CIVE 5093.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Civil & Environ. Eng**CIVE 4103 Construction Simulation****Prerequisites:** Senior standing and CIVE 4273 with minimum grade of "C."**Description:** This course introduces students to effective ways of modeling construction processes and technologies. It provides an investigation of quantitative methods used for the design and analysis of construction operations to maximize productivity and minimize resource idleness. It includes discussions on queueing theory, line-of-balance techniques, linear programming and simulation. Comprehensive group projects that involve modeling and analyzing actual construction operations will be integral parts of this course. Course is a senior elective. May not be used for degree credit with CIVE 5103.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Civil & Environ. Eng

**CIVE 4113 Construction Business Management****Prerequisites:** Senior standing.**Description:** Fundamental theories and applied methods of financial management of construction companies. The spectrum of the present and future practice of business management at the construction company level. Basic construction business operations in the context of construction accounting, financial management, cash flow analysis, financial planning, and risk analysis. May not be used for degree credit with CIVE 5113.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Civil & Environ. Eng**CIVE 4123 The Legal & Regulatory Environment of Civil Engineering****Prerequisites:** Professional School.**Description:** The U.S. and Oklahoma court systems. Tort law and labor law having an impact on engineering and construction. Union organization and activities. Government contracting and the laws governing it. Discussions of the Occupation Safety and Health Act and Americans with Disabilities Act. In-Depth look at environmental policy, laws, and regulations affecting engineering, including NEPA, CWA, SDWA, RCRA, CERCLA and CAA Water law. May not be used for degree credit with CIVE 5123.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Civil & Environ. Eng**CIVE 4133 Construction Contracts and Specifications****Prerequisites:** Senior standing.**Description:** The nature of contracts. Contract documents. Master format. Principles of specification writing. Contract types. Bonds and insurance. Bidding. Subcontracting. Disputes and disputes resolution. Course is a senior elective. May not be used for degree credit with CIVE 5133.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Civil & Environ. Eng**CIVE 4143 Environmental Engineering Design****Prerequisites:** Minimum grade of "C" in each; CIVE 3714 and CIVE 3833 and CIVE 3853 and CIVE 4833, and within last semester of program completion.**Description:** Actors involved in the design of engineered environmental systems. Solving "real world" environmental engineering problems. Design experience using decision-making techniques, integrating and expanding upon current knowledge, and defending decisions made. Economic, environmental, social, and regulatory aspects of environmental engineering design. Capstone course. May not be used for degree credit with CIVE 4043.**Credit hours:** 3**Contact hours:** Lecture: 2 Lab: 2 Contact: 4**Levels:** Undergraduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Civil & Environ. Eng**CIVE 4153 Contract Administration****Prerequisites:** Senior standing.**Description:** Methods and techniques of tracking and control of construction projects. Evaluation of current research findings to contract implementation. Course is a senior elective. May not be used for degree credit with CIVE 5153.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Civil & Environ. Eng**CIVE 4163 Construction Equipment Management****Prerequisites:** Senior standing.**Description:** Analysis of construction equipment. Performance under various operating conditions. Application of engineering fundamentals to construction methods. Selection and costs of equipment, prediction of equipment production rates, and unit costs of work in place. Course is a senior elective. May not be used for degree credit with CIVE 5163.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Civil & Environ. Eng**CIVE 4183 Construction Estimating****Prerequisites:** Senior standing, and concurrent prerequisite CIVE 4273 with minimum grade of "C."**Description:** The construction industry, its makeup, operation, estimating, and bidding procedures. Theory and practice of estimating materials, labor, equipment, and overhead costs for various types of construction. Emphasis on preliminary cost estimates during the conceptual design phase of a construction project. May not be used for degree credit with CIVE 5183.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Civil & Environ. Eng**CIVE 4193 BIM for Construction****Prerequisites:** Senior standing, and concurrent prerequisite CIVE 4273 with minimum grade of "C."**Description:** The course focuses on advanced information systems used to control and predict project performance (cost and schedule) in construction. Building information Modeling is examined as a systems approach of integrating design and construction for the benefit of developing construction work packages, 4D simulations, clash detection, and the process of implementing BIM on an enterprise to project level. May not be used for degree credit with CIVE 5193.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Civil & Environ. Eng

**CIVE 4243 Use and Design of Geosynthetics**

**Prerequisites:** Senior standing and CIVE 3714 with minimum grade of "C."

**Description:** Description of types of geosynthetics available for engineering uses. Pertinent engineering properties required to design for various functions, basic design methodology for geosynthetics for various functions, and construction and performance considerations. May not be used for degree credit with CIVE 5243.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4273 Construction Engineering and Project Management**

**Prerequisites:** Senior standing and ENGR 1412 with minimum grade of "C."

**Description:** Principles and practice of construction engineering and project management. Project planning, development of cost estimates and project schedules, construction methods and fundamental terminology used in the engineering and construction industry. May not be used for degree credit with CIVE 5073.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

**CIVE 4283 Numerical Methods in Geotechnical Engineering**

**Prerequisites:** CIVE Professional School and CIVE 3714 with minimum grade of C.

**Description:** The course covers a brief review of some fundamental principles of finite element method and its application to problems in geotechnical engineering. Students will use computer programs to perform analysis of geotechnical earth structures including flow through porous media, unsaturated and expansive soils. May not be used for degree credit with CIVE 5283.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4293 Design and Analysis of Earth Retaining Structures**

**Prerequisites:** CIVE professional school and CIVE 3714 minimum grade of C.

**Description:** Lateral earth pressure theories. Use of earth retaining structures in civil engineering construction. Design and analysis of gravity, sheet pile, soil nail, and MSE walls by hand calculation and with a computer program. May not be used for degree credit with CIVE 5293.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4303 Systems Analysis for Civil Engineers**

**Prerequisites:** Senior standing and CIVE 3633 or concurrent enrollment.

**Description:** Synthesis of systems modeling and simulation techniques, mathematical optimization procedures, and evaluation tools of multi-attributed systems including utility theory and decision analysis. Mathematical optimization techniques in the areas of resource allocation, transportation and water resources systems planning, structural design, construction management, and environmental and ecological problems. Course is a senior elective. May not be used for degree credit with CIVE 5303.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4313 Highway Traffic Operations**

**Prerequisites:** Senior standing and CIVE 3633 or concurrent enrollment.

**Description:** Level of service, capacity and service volume concepts. Operational characteristics of uninterrupted-flow and interrupted-flow of traffic facilities. The 1985 HCM procedures for analyzing the capacity of freeways, multi-lane and two-lane rural highways, urban arterials, signalized and unsignalized street intersections, and transit and pedestrian facilities. Administrative and planning actions for congestion management. Design alternatives and improvement strategies for effective use of urban arterial street width. Course is a senior elective. May not be used for degree credit with CIVE 5313.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4323 Civil Infrastructure Systems**

**Prerequisites:** Senior standing and CIVE 3633 with minimum grade of "C".

**Description:** The course presents a unified approach to the management of civil infrastructure systems. Topics of discussion include various aspects of asset management analytical methods, data collection technologies, life cycle cost, prioritization and optimization, climate change and sustainability. Types of infrastructure considered in the course include pavements (roads and airports), bridges, drainage and sewer systems, water supply systems, and power supply facilities. May not be used for degree credit with CIVE 5323.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng



**CIVE 4343 Urban Transportation Planning**

**Prerequisites:** Senior standing and CIVE 3633 or concurrent enrollment.

**Description:** Determinants of demand for transportation and models for demand forecasting. Performance characteristics of transportation systems and models for performance. Quantitative analysis of multimodal transportation networks including prediction of flow patterns and service quality. Evaluation of social, environmental, and political impacts of transportation decisions. Application of systems analysis techniques to the generation, evaluation, and selection of alternative transportation systems. Course is a senior elective. May not be used for degree credit with CIVE 5343.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4363 Design and Planning of Airports**

**Prerequisites:** Senior standing and CIVE 3633 or concurrent enrollment.

**Description:** Nature of civil aviation. Aircraft characteristics and performance related to airport planning and design. Air traffic control and navigation systems. Basics of airport planning and airport demand forecasting. Analysis of airport capacity and delays. Runway length requirements. Configuration and geometric design of runways, taxiways, holding aprons, and landing areas. Airport lighting, marking, and signing. Drainage and noise control. Course is a senior elective. May not be used for degree credit with CIVE 5363.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4373 Design of Traffic Control Systems**

**Prerequisites:** Senior standing and CIVE 3633 or concurrent enrollment.

**Description:** Traffic control systems design, available technological options, and range of agency needs. Design of vehicle detectors, controllers, communications links, signal display hardware, and wiring. Development of timing plans using computer simulation models. Freeway surveillance and control: ramp metering, incident detection, and motorist information systems. Preparation of contractual documents and construction supervision. Course is a senior elective. May not be used for degree credit with CIVE 5373.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4383 Geometric Design of Highways**

**Prerequisites:** Senior standing and CIVE 3633 or concurrent enrollment.

**Description:** Geometric, functional, and aesthetic aspects of roadway design. Alignment, sight distance, at-grade intersections, interchanges, and freeway systems. Design tools and techniques. Course is a senior elective. May not be used for degree credit with CIVE 5383.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4403 Advanced Strength of Materials**

**Prerequisites:** Senior standing and CIVE 3413 with minimum grade of "C".

**Description:** General states of stress and strain, theories of failure, energy principles, beam bending, shear center, torsion of prismatic shafts, beams on elastic foundations, plates and shells, elastic stability. May not be used for degree credit with CIVE 5403.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4413 Classical and Matrix Methods of Structural Analysis**

**Prerequisites:** Senior standing and CIVE 3413 with minimum grade of "C".

**Description:** Advanced analysis of indeterminate frames, trusses and arches by classical, numerical, energy, and stiffness methods with emphasis on methods with emphasis on methods for hand computations and development of matrix analysis. May not be used for degree credit with CIVE 5413.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4483 Concrete Testing and Monitoring Methods**

**Prerequisites:** Senior standing and CIVE 3623 with minimum grade of "C," or CIVE 3523 with minimum grade of "C."

**Description:** Standard and advanced concrete testing and monitoring methods used for strength assessment of concrete, along with other various material properties and integrity issues in the laboratory and in the field. Principles, applications and limitations, procedures, equipment operation and result interpretation are discussed for each destructive and non-destructive evaluation technique reviewed: mechanical, chemical, electrical, ultrasonic and acoustics, thermography, radiography. This course includes a laboratory session to develop manipulation skills and review concepts presented in lectures. Course is a senior elective. May not be used for degree credit with CIVE 5483.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

**CIVE 4493 Infrastructure Condition Assessment and Repair**

**Prerequisites:** Senior standing and CIVE 3623 with minimum grade of "C," and CIVE 3523 with minimum grade of "C."

**Description:** The course provides guidelines on how to conduct a practical condition assessment of reinforced concrete infrastructure, which includes discussions on performing condition surveys, preliminary and detailed investigations; along with concrete properties, distress features and associated causes, diagnostics testing; reporting findings and recommendation. It also includes a discussion in basic repair methods and materials. Course is a senior elective. May not be used for degree credit with CIVE 5493.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4513 Advanced Reinforced Concrete Design****Prerequisites:** Senior standing and CIVE 3523 with minimum grade of "C".**Description:** Advanced topics in reinforced concrete design with emphasis on frames, slabs and earthquake resistant structures. May not be used for degree credit with CIVE 5513.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Civil & Environ. Eng**CIVE 4523 Advanced Steel Structure Design****Prerequisites:** Senior standing and CIVE 3513 with minimum grade of "C".**Description:** Advanced topics in steel design such as plastic design, plate girders, composite design, fatigue and fracture, stability and bracing design. May not be used for degree credit with CIVE 5523.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Civil & Environ. Eng**CIVE 4533 Prestressed Concrete****Prerequisites:** Senior standing and CIVE 3523 with minimum grade of "C".**Description:** Design of simple and continuous prestressed concrete beams. Behavior under overload. Calculation of prestress losses and deflections. May not be used for degree credit with CIVE 5533.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Civil & Environ. Eng**CIVE 4563 Structural Dynamics****Prerequisites:** Senior standing and minimum grade of "C" in CIVE 3413 and ENSC 2123.**Description:** Analysis of linear, elastic damped and undamped systems with single and multiple degrees of freedom undergoing free forced vibration. Lumped and distributed mass systems. Computational techniques to numerically integrate the equations of motion. May not be used for degree credit with CIVE 5563.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Civil & Environ. Eng**CIVE 4573 Timber Design****Prerequisites:** Senior standing and CIVE 3513 or CIVE 3523 with minimum grade of "C".**Description:** Design of structural timber members, assemblies, and connections in accordance with ANSA/AF&PA, NDS specifications. Design, build, and test timber structure. Course is a senior elective. May not be used for degree credit with CIVE 5573.**Credit hours:** 3**Contact hours:** Lecture: 2 Lab: 2 Contact: 4**Levels:** Undergraduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Civil & Environ. Eng**CIVE 4583 Advanced Construction Materials****Prerequisites:** CIVE Professional School and CIVE 3623 with minimum grade of "C".**Description:** Undergraduate elective course addresses advanced topics on fundamental material properties and related design criteria for products commonly used in civil construction: timber and engineered wood products, metals and alloys, polymers and fiber reinforced composites; and glass. Lectures will include material specific topics on: physical, chemical and mechanical properties; fabrication methods; use and applications; standards, testing and quality control measures; selection and design criteria. May not be used for degree credit for CIVE 5583.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Civil & Environ. Eng**CIVE 4653 Asphalt Materials and Mix Design****Prerequisites:** Senior standing and CIVE 3623 with minimum grade of "C".**Description:** Principles of asphalt concrete mix design including material characteristics and performance. Evaluation of Superpave mix design methods. Asphalt cements, rubberized asphalt polymer asphalts, emulsions, cutbacks, and aggregates. Laboratory sessions focused on the engineering properties of the materials discussed. May not be used for degree credit with CIVE 5653.**Credit hours:** 3**Contact hours:** Lecture: 2 Lab: 3 Contact: 5**Levels:** Undergraduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Civil & Environ. Eng**CIVE 4673 Concrete Materials and Mix Design****Prerequisites:** Senior standing and CIVE 3623 with minimum grade of "C".**Description:** Principles of concrete mix design, including material characteristics, strength and durability requirements, environmental effects and forensic analysis. ACI and PCA mix design procedures. Laboratory on theoretical and practical aspects of concrete technology. Course is a senior elective. May not be used for degree credit with CIVE 5673.**Credit hours:** 3**Contact hours:** Lecture: 2 Lab: 3 Contact: 5**Levels:** Undergraduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Civil & Environ. Eng**CIVE 4693 Pavement Design and Analysis****Prerequisites:** Senior standing and minimum grade of "C" in CIVE 3633 and CIVE 3623.**Description:** Principles of pavement design, including stress analyses, load and environmental effects, and material characteristics. AASHTO, PCA and AI methods of pavement design. Computer methods practical aspects of life cycle cost analyses and construction methods. May not be used for degree credit with CIVE 5693.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Civil & Environ. Eng

**CIVE 4711 Basic Soils Testing Laboratory**

**Prerequisites:** Non-CIVE majors only, ENSC 2113 with minimum grade of "C".

**Description:** Laboratory measurements of the physical and mechanical properties of soils; grain size distribution, plasticity, permeability, compaction, compressibility, and shear strength.

**Credit hours:** 1

**Contact hours:** Lab: 2 Contact: 2

**Levels:** Undergraduate

**Schedule types:** Lab

**Department/School:** Civil & Environ. Eng

**CIVE 4723 Foundation Engineering**

**Prerequisites:** Senior standing and CIVE 3714 with minimum grade of "C."

**Description:** Types of structural foundations including footings, mats, rafts, piles and drilled shafts. Site characteristics, exploration programs, field data, test results, construction materials and methods as basis for selection of type of foundation and design. Geotechnical design procedures and considerations. Course is a senior elective. May not be used for degree credit with CIVE 5723.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4733 Soil Mechanics**

**Prerequisites:** Senior standing and CIVE 3714 with minimum grade of "C."

**Description:** Application of soil mechanics principles and concepts in geotechnical areas of permeability and seepage, settlement analysis, bearing capacity, lateral earth pressures and retaining walls, slope stability, and metastable soils. Course is a senior elective. May not be used for degree credit with CIVE 5713.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4743 Project Engineering and Management**

**Prerequisites:** Senior standing and concurrent prerequisite CIVE 4273 with minimum grade of "C".

**Description:** Management of the design and construction of civil engineering projects. Topics include owner's study, formation of project teams, design coordination, construction, and project closeout. Course is a senior elective. May not be used for degree credit with CIVE 5143.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4753 Engineering Soil Stabilization**

**Prerequisites:** Senior standing and CIVE 3714 with minimum grade of "C."

**Description:** Theoretical and practical aspects of engineering soil stabilization as a method for improving and upgrading low quality and unstable soils for engineering purposes. Use of lime, fly ash, portland cement, asphalt, and other physical and chemical admixtures. Application of deep foundation stabilization methods such as preloading, deep compaction, injection and reinforcement. Course is a senior elective. May not be used for degree credit with CIVE 5753.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4773 Soil-Structure Interaction**

**Prerequisites:** Senior standing and CIVE 3714 with minimum grade of "C."

**Description:** The mechanical interaction effects between soils and structures using suitable engineering procedures such as finite differences and finite element methods. Civil engineering problems where interaction effects are most dominant including grade beams (beams on elastic foundation), axially- and laterally-loaded piles, cantilever, and anchored sheet pile walls. Course is a senior elective. May not be used for degree credit with CIVE 5743.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4833 Unit Operations in Environmental Engineering**

**Prerequisites:** Senior standing and minimum grade of "C" in CIVE 3813.

**Description:** Fundamental principles of water and wastewater treatment, including basic theory and development of design parameters. Application of these to the design of unit operations and processes in various treatment plants. May not be used for degree credit with CIVE 5843.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4853 Bioremediation**

**Prerequisites:** Senior standing and minimum grade of "C" in MATH 2153, and (CIVE 4903 or MICR 4013).

**Description:** Science and technologies for the site selection and bioremediation of hazardous contamination in soil, sediment and groundwater systems. Includes geochemical reactions and analysis, pollutant fate and transport modeling, microbial degradation mechanisms, natural attenuation, and measurements of success. May not be used for degree credit with CIVE 5853.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng



**CIVE 4863 Advanced Unit Operations in Environmental Engineering**

**Prerequisites:** Senior standing and CIVE 4833 with minimum grade of "C."  
**Description:** Theory and design of advanced physical-chemical water and wastewater treatment processes applied to municipal, industrial, and hazardous waste situations. Course is a senior elective. May not be used for degree credit with CIVE 5863.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4873 Air Pollution Control Engineering**

**Prerequisites:** Senior standing and CIVE 4833 with minimum grade of "C."  
**Description:** Causes, effects, and control of atmospheric pollution. Course is a senior elective. May not be used for degree credit with CIVE 5873.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4883 Introduction to Environmental Modeling**

**Prerequisites:** Senior standing and minimum grade of "C" in CIVE 3813 and CIVE 3833.

**Description:** Intended as an introductory course for senior undergraduate students to the fundamentals of environmental modeling. Develops material necessary to construct models capable of identifying contaminant distributions at future times and space for water and air pollution applications. Advanced topics such as stochastic modeling, ecological risk assessment, neural modeling and spatial statistical analysis among others will be presented according to the backgrounds and interests of the enrolled students. May not be used for degree credit with CIVE 5833 and BAE 5343.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4903 Microbiology for Engineers**

**Prerequisites:** Senior standing.

**Description:** Microbiology relates to many aspects of engineering, primarily environmental engineering. The class will cover the roles of bacteria in water and wastewater treatment, the bioremediation of hazardous substances, the mechanisms of antibiotic resistance, the molecular tools for studying and tracking bacteria, and special topics with regards to bacteria in common engineered environments. Basic microbiology and biochemistry will be covered throughout the course providing necessary background. May not be used for degree credit with CIVE 5903.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4913 Groundwater Hydrology**

**Prerequisites:** Senior standing and minimum grade of "C" in CIVE 3843.  
**Description:** Theory of groundwater movement, storage, exploration and pumping tests. Design of groundwater recovery and recharge systems. May not be used for degree credit with CIVE 5913.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4923 Environ Risk Assessment**

**Prerequisites:** Professional School and minimum grade of "C" in CIVE 3813 and STAT 4033 or STAT 4073 with minimum grade of "C".

**Description:** Environmental risk assessment and management. Applies elements of statistics, probability and environmental simulation to determine the public health and ecological risks from activities of humans. May not be used for degree credit with CIVE 5823.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4933 Water Treatment**

**Prerequisites:** Senior standing and CIVE 4833 with minimum grade of "C".

**Description:** Theory, design, and operation of water treatment plants. Sizing of various unit processes. Water treatment plant control procedures. May not be used for degree credit with CIVE 5933.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4943 Risk and Failure Analysis of Dams**

**Prerequisites:** CIVE Professional School.

**Description:** Analyzing, evaluating and managing risks to Dams and providing a rigorous, systematic, and thorough approach to sustain and support of safety aspects. Evaluating CUASI Data to support aspects of the environment near and around Dams. Using new technologies such as ArcInfo to provide solutions to problems. May not be used for degree credit with CIVE 5043.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4953 Biological Waste**

**Prerequisites:** Senior standing and CIVE 4833 with minimum grade of C.

**Description:** Fundamentals of microbial systems applied to waste treatment processes. Standard suspended-growth and fixed biofilm wastewater and sludge suspensions and treatment system design calculations. May not be used for degree credit with CIVE 5953.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4963 Open Channel Flow**

**Prerequisites:** Senior standing and minimum grade of "C" in CIVE 3833.

**Description:** Open channel hydraulics, energy and momentum concepts, resistance, channel controls and transitions, flow routing and sediment transport. May not be used for degree credit with CIVE 5963.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 4973 Concrete Durability**

**Prerequisites:** Senior standing and CIVE 3623 with minimum grade of "C."

**Description:** This course investigates the mechanisms, test methods, and evaluation procedures for the primary mechanisms for durability issues in concrete. Emphasis is placed on providing a practical and theoretical overview of the topics. Special topics may be covered with the interest of the students. Course is a senior elective. May not be used for degree credit with CIVE 5273.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

**CIVE 4983 Residuals & Solid Waste Management**

**Prerequisites:** Professional School and CIVE 4833 with minimum grade of "C".

**Description:** Theory, design and operation of systems for handling, treatment, and disposal of process sludge (water treatment, wastewater treatment, industrial) and solid wastes. Potential material reclamation options. May not be used for degree credit with CIVE 5883.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5000 Master's Thesis**

**Description:** A student studying for a master's degree will enroll in this course for a total of 6 credits if a thesis is to be written. Offered for variable credit, 1-6 credit hours, maximum of 6 credit hours.

**Credit hours:** 1-6

**Contact hours:** Contact: 1-6 Other: 1-6

**Levels:** Graduate

**Schedule types:** Independent Study

**Department/School:** Civil & Environ. Eng

**CIVE 5010 Civil Engineering Seminar**

**Description:** Review of literature of major fields of civil engineering. Offered for variable credit, 1-3 credit hours, maximum of 15 credit hours.

**Credit hours:** 1-3

**Contact hours:** Contact: 1-3 Other: 1-3

**Levels:** Graduate

**Schedule types:** Independent Study

**Department/School:** Civil & Environ. Eng

**CIVE 5013 Aquatic Chemistry**

**Description:** Application of chemical principles to environmental problems. Chemical kinetics, chemical equilibrium, acid-base chemistry, development of pc-pH diagrams, and coordination chemistry. Precipitation and dissolution reactions and oxidation-reduction reactions. CHEM 1515 or equivalent background required. May not be used for degree credit with CIVE 4013.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5020 Civil Engineering Research**

**Prerequisites:** Graduate standing and approval of major professor.

**Description:** Research and investigations other than thesis studies. Offered for variable credit, 1-6 credit hours, maximum of 6 credit hours.

**Credit hours:** 1-6

**Contact hours:** Contact: 1-6 Other: 1-6

**Levels:** Graduate

**Schedule types:** Independent Study

**Department/School:** Civil & Environ. Eng

**CIVE 5030 Engineering Practice**

**Prerequisites:** Approval of adviser.

**Description:** Professional supervised civil engineering practice involving authentic projects for which the student assumes a degree of professional responsibility. Activities must be approved in advance by the student's adviser and may consist of engineering experience on-campus or off-campus, or both. Periodic reports, both oral and written, are required as specified by the adviser. Offered for variable credit, 1-6 credit hours, maximum of 9 credit hours.

**Credit hours:** 1-6

**Contact hours:** Contact: 1-6 Other: 1-6

**Levels:** Graduate

**Schedule types:** Independent Study

**Department/School:** Civil & Environ. Eng

**CIVE 5033 GIS Applications for Water Resources**

**Prerequisites:** Graduate standing or professional school.

**Description:** Application of theoretical and practical components of geographic information system for engineers. Digital mapping of water resources information, spatial coordinate systems and digital terrain analysis using digital elevation models. Analysis of a variety of spatial data in efficient and effective manner. Introduction of geospatial analytical algorithms to solve civil and environmental problems.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5043 Risk and Failure Analysis of Dams**

**Prerequisites:** Graduate standing or professional school.

**Description:** Analyzing, evaluating and managing risks to Dams and providing a rigorous, systematic, and thorough approach to sustain and support of safety aspects. Evaluating CUASI Data to support aspects of the environment near and around Dams. Using new technologies such as ArcInfo to provide solutions to problems.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5053 Transportation Geotechnics**

**Prerequisites:** Graduate standing.

**Description:** This course focuses on the application of geotechnical engineering concepts to the analysis, design, and construction of transportation infrastructure. Topics covered include: soil classification systems, soil variability; subgrade evaluation procedures, repeated loading behavior of soils; soil compaction and field control; and subgrade stability for transportation facility engineering. May not be used for degree credit with CIVE 4053.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5063 Introduction to Railroad Engineering**

**Prerequisites:** Graduate standing.

**Description:** This course provides civil engineering students a technical transportation course in Railroad Engineering. It covers a wide spectrum of railway engineering, including the basic principles, railroad design, construction, operation, evaluation and maintenance of rail infrastructure and networks. The students are expected to develop small group skills through team homework assignments and class interaction. May not be used for degree credit with CIVE 4063.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5073 Construction Engineering and Project Management**

**Description:** Principles and practice of construction engineering and project management. Project planning, development of cost estimates and project schedules, construction methods and fundamental terminology used in the engineering and construction industry. May not be used for degree credit with CIVE 4273.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Graduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

**CIVE 5080 Engineering Problems**

**Prerequisites:** Permission of instructor.

**Description:** Problems of particular interest to graduate students in the field of civil engineering. This course meets the criteria for a creative component. Not to be included on thesis plans. Offered for variable credit, 1-3 credit hours, maximum of 3 credit hours.

**Credit hours:** 1-3

**Contact hours:** Contact: 1-3 Other: 1-3

**Levels:** Graduate

**Schedule types:** Independent Study

**Department/School:** Civil & Environ. Eng

**CIVE 5083 Applied Statistics for Civil Engineers**

**Description:** This course covers subjects including statistical fundamentals; continuous, count, discrete dependent variable models, random parameter models, and Bayesian modeling that are widely used in civil, particularly transportation engineering. Course is a senior elective. May not be used for degree credit with CIVE 4083.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5093 Transportation Safety and Analysis**

**Prerequisites:** Graduate standing.

**Description:** This course introduces fundamental concepts for performing traffic safety analyses, including safety management systems, different safety countermeasures, development of statistical models with countermeasures and their effectiveness, economic analyses, and crash investigation. Students should be prepared to apply these important safety concepts in professional practice. May not be used for degree credit with CIVE 4093.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5103 Construction Simulation**

**Description:** This course introduces students to effective ways of modeling construction processes and technologies. It provides an investigation of quantitative methods used for the design and analysis of construction operations to maximize productivity and minimize resource idleness. It includes discussions on queueing theory, line-of-balance techniques, linear programming and simulation. Comprehensive group projects that involve modeling and analyzing actual construction operations will be integral parts of this course. May not be used for degree credit with CIVE 4103.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5113 Construction Business Management**

**Description:** Fundamental theories and applied methods of financial management of construction companies. The spectrum of the present and future practice of business management at the construction company level. Basic construction business operations in the context of construction accounting, financial management, cash flow analysis, financial planning, and risk analysis. May not be used for degree credit with CIVE 4113.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5123 The Legal and Regulatory Environment of Engineering**

**Prerequisites:** Graduate standing or admission to CIVE professional school required.

**Description:** The U.S. and Oklahoma court systems. Tort law and labor law having an impact on engineering and construction. Union organization and activities. Government contracting and the laws governing it. Discussions of the Occupation Safety and Health Act and Americans with Disabilities Act. In-Depth look at environmental policy, laws, and regulations affecting engineering, including NEPA, CWA, SDWA, RCRA, CERCLA and CAA Water law.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate, Undergraduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5133 Construction Contracts and Specifications**

**Description:** The nature of contracts. Contract documents. Master format. Principles of specification writing. Contract types. Bonds and insurance. Bidding. Subcontracting. Disputes and disputes resolution. May not be used for degree credit with CIVE 4133.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**Additional Fees:** Civil Engineering Equip Use fee of \$10 applies.

**CIVE 5143 Project Engineering and Management**

**Description:** Management of the design and construction of civil engineering projects. Topics include owner's study, formation of project teams, design coordination, construction, and project closeout. May not be used for degree credit with CIVE 4743.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5153 Contract Administration**

**Description:** Methods and techniques of tracking and control of construction projects. Evaluation of current research findings to contract implementation. May not be used for degree credit with CIVE 4153.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5163 Construction Equipment Management**

**Description:** Analysis of construction equipment. Performance under various operating conditions. Application of engineering fundamentals to construction methods. Selection and costs of equipment, prediction of equipment production rates, and unit costs of work in place. May not be used for degree credit with CIVE 4163.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5183 Construction Estimating**

**Prerequisites:** Graduate standing and CIVE major.

**Description:** The construction industry, its makeup, operation, estimating, and bidding procedures. Theory and practice of estimating, materials, labor, equipment, and overhead costs for various types of construction. Emphasis on preliminary cost estimates during the conceptual design phase of a construction project. May not be used for degree credit with CIVE 4183.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5193 BIM for Constructions**

**Prerequisites:** CIVE major and graduate standing.

**Description:** The course focuses on advanced information systems used to control and predict project performance (cost and schedule) in construction. Building information modeling is examined as a systems approach of integrating design and construction for the benefit of developing construction work packages, 4D simulations, clash detection, and the process of implementing BIM on an enterprise to project level. May not be used for degree credit with CIVE 4193.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5203 Pavement Rehabilitation, Management and Safety**

**Prerequisites:** Graduate standing or senior standing with instructor approval.

**Description:** Understand and perform pavement evaluations of function, structure, surface condition, and surface safety and learn various types of equipment for evaluating pavement function, structure, and surface condition and safety. Describe techniques for rehabilitation of flexible and rigid pavements, and overall objectives and major components of a pavement management system. Understand and explain the basic techniques of safety analysis based on pavement surface data.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5243 Use and Design of Geosynthetics**

**Prerequisites:** Graduate student.

**Description:** Description of types of geosynthetics available for engineering uses. Pertinent engineering properties required to design for various functions, basic design methodology for geosynthetics for various functions, and construction and performance considerations. May not be used for degree credit with CIVE 4243.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5253 Sensors and their Applications for Pavement**

**Prerequisites:** Graduate standing or senior standing with instructor approval.

**Description:** Sensor Principles of Falling Weight Deflectometer (FWD), Rolling Weight Deflectometer (RWD) and Traffic Speed Deflectometer (TSD); 2D and 3D laser imaging as used in pavement surface condition survey; Laser rangefinders and accelerometers for pavement longitudinal profile; Friction and texture measurement of pavement surface; New software and mobile tools for presenting sensor data with HTML5; 3D visualization and database management with pavement sensor data; Inertial navigation system and high-precision gyro for pavement data positioning; LIDAR and its usage for infrastructure management.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5273 Concrete Durability**

**Prerequisites:** CIVE 5673 Concrete Mixture Design and graduate standing or permission of instructor.

**Description:** This course investigates the mechanisms, test methods, and evaluation procedures for the primary mechanisms for durability issues in concrete. Emphasis is placed on providing a practical and theoretical overview of the topics. Special topics may be covered with the interest of the students.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Graduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

**CIVE 5283 Numerical Methods in Geotechnical Engineering**

**Prerequisites:** Graduate standing, or professional school and CIVE 3714 for undergraduates.

**Description:** The course covers a brief review of some fundamental principles of finite element method and its application to problems in geotechnical engineering. Students will use computer programs to perform analysis of geotechnical earth structures including flow through porous media, unsaturated and expansive soils.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5293 Design and Analysis of Earth Retaining Structures**

**Prerequisites:** CIVE major and graduate standing.

**Description:** Lateral earth pressure theories. Use of earth retaining structures in civil engineering construction. Design and analysis of gravity, sheet pile, soil nail, and MSE walls by hand calculation and with a computer program. May not be used for degree credit with CIVE 4293.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5303 Systems Analysis for Civil Engineers**

**Description:** Synthesis of systems modeling and simulation techniques, mathematical optimization procedures, and evaluation tools of multi-attributed systems including utility theory and decision analysis. Mathematical optimization techniques in the areas of resource allocation, transportation and water resources systems planning, structural design, construction management, and environmental and ecological problems. May not be used for degree credit with CIVE 4303.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5313 Highway Traffic Operations**

**Description:** Level of service, capacity and service volume concepts. Operational characteristics of uninterrupted-flow and interrupted-flow traffic facilities. The 1985 HCM procedures for analyzing the capacity of freeways, multilane and two-lane rural highways, urban arterials, signalized and unsignalized street intersections, and transit and pedestrian facilities. Administrative and planning actions for congestion management. Design alternatives and improvement strategies for effective use of urban arterial street width. May not be used for degree credit with CIVE 4313.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5323 Civil Infrastructure Systems**

**Prerequisites:** Graduate student.

**Description:** The course presents a unified approach to the management of civil infrastructure systems. Topics of discussion include various aspects of asset management: analytical methods, data collection technologies, life cycle cost, prioritization and optimization, climate change and sustainability. Types of infrastructure considered in the course include pavements (roads and airports), bridges, drainage and sewer systems, water supply systems, and power supply facilities. May not be used for degree credit with CIVE 4323.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5333 Reliability and Risk of Components and Systems**

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng



**CIVE 5343 Urban Transportation Planning**

**Description:** Determinants of demand for transportation and models for demand forecasting. Performance characteristics of transportation systems and models for performance. Quantitative analysis of multimodal transportation networks including prediction of flow patterns and service quality. Evaluation of social, environmental, and political impacts of transportation decisions. Application of systems analysis techniques to the generation, evaluation, and selection of alternative transportation systems. May not be used for degree credit with CIVE 4343.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5363 Design and Planning of Airports**

**Description:** Nature of civil aviation. Aircraft characteristics and performance related to airport planning and design. Air traffic control and navigation systems. Basics of airport planning and airport demand forecasting. Analysis of airport capacity and delays. Runway length requirements. Configuration and geometric design of runways, taxiways, holding aprons, and landing areas. Airport lighting, marking, and signing. Drainage and noise control. May not be used for degree credit with CIVE 4363.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5373 Design of Traffic Control Systems**

**Description:** Traffic control systems design, available technological options, and range of agency needs. Design of vehicle detectors, controllers, communications links, signal display hardware, and wiring. Development of timing plans using computer simulation models. Freeway surveillance and control: ramp metering, incident detection, and motorist information systems. Preparation of contractual documents and construction supervision. May not be used for degree credit with CIVE 4373.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5383 Geometric Design of Highways**

**Description:** Geometric, functional, and aesthetic aspects of roadway design. Alignment, sight distance, at-grade intersections, interchanges, and freeway systems. Design tools and techniques. May not be used for degree credit with CIVE 4383.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5403 Advanced Strength of Materials**

**Description:** General states of stress and strain, theories of failure, energy principles, beam bending, shear center, torsion of prismatic shafts, beams on elastic foundations, plates and shells, elastic stability. May not be used for degree credit with CIVE 4403.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5413 Classical and Matrix Methods of Structural Analysis**

**Prerequisites:** Graduate standing or admission to CIVE professional school, and CIVE 3413.

**Description:** Advanced analysis of indeterminate frames, trusses and arches by classical, numerical, energy, and stiffness methods with emphasis on methods for hand computations and development of matrix analysis.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5423 Matrix Analysis of Structures**

**Prerequisites:** Graduate standing or admission to CIVE professional school required and CIVE 3413.

**Description:** Matrix analysis of two- and three-dimensional trusses and frames. Development of member stiffness matrices. Assemblage of structure matrices by direct stiffness method. Computer programs for structural analysis.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5433 Energy Methods in Applied Mechanics**

**Prerequisites:** Graduate standing or admission to CIVE professional school required and CIVE 3413 and MATH 2233 or MAE 3323.

**Description:** Advanced structural mechanics from the standpoint of virtual work; energy principles and variational calculus applied to the analysis of structures, mechanisms, dynamics, and vibrations.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5453 Engineering Analysis**

**Description:** Advanced, classical mathematical skills for engineers.

Dimensional Analysis, General Tensor Analysis, Curvilinear Coordinates, Partial Differential Equations, Perturbation Theory, Integral Equations, Special Functions, Eigen Function Analysis, Integral Transform Methods, Variational Methods.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5473 Steel Plastic Design**

**Prerequisites:** Graduate standing or CIVE 3413 Structural Analysis and instructor approval.

**Description:** This course is for incoming graduate students that are not familiar with LRFD AISC based steel design. Topics typically covered in the undergraduate course are covered with additional topics.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Lab: 2 Contact: 5

**Levels:** Graduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

**CIVE 5483 Concrete Testing and Monitoring Method**

**Prerequisites:** Graduate student.

**Description:** Standard and advanced concrete testing and monitoring methods used for strength assessment of concrete, along with other various material properties and integrity issues in the laboratory and in the field. Principles, applications and limitations, procedures, equipment operation and result interpretation are discussed for each destructive and non-destructive evaluation technique reviewed: mechanical, chemical, electrical, ultrasonic and acoustics, thermography, radiography. This course includes a laboratory session to develop manipulation skills and review concepts presented in lectures. May not be used for degree credit with CIVE 4483.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Graduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

**CIVE 5493 Infrastructure Condition Assessment and Repair**

**Prerequisites:** Graduate student.

**Description:** The course provides guidelines on how to conduct a practical condition assessment of reinforced concrete infrastructure, which includes discussions on performing condition surveys, preliminary and detailed investigations; along with concrete properties, distress features and associated causes, diagnostics testing; reporting findings and recommendation. It also includes a discussion in basic repair methods and materials. May not be used for degree credit with CIVE 4493.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5503 Computer-Aided Structural Analysis and Design**

**Prerequisites:** Graduate standing or admission to CIVE professional school required and CIVE 3413, CIVE 3513, CIVE 3523 (or concurrent enrollment); or permission of instructor.

**Description:** Major comprehensive design experience. Promotion of a design office atmosphere in using a team approach. Industry practitioners provide design projects and critique results. Analysis and design of complex structures and preparation of contract documents and drawings. Emphasis on modern computer-based computation and presentation tools.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5513 Advanced Reinforced Concrete Design**

**Prerequisites:** Graduate standing or admission to CIVE professional school required and CIVE 3523.

**Description:** Advanced topics in reinforced concrete design with emphasis on frames, slabs, and earthquake-resistant structures.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5523 Advanced Steel Structure Design**

**Prerequisites:** Graduate standing or admission to CIVE professional school required and CIVE 3513.

**Description:** Advanced topics in steel design such as plastic design, plate girders, composite design, fatigue and fracture, stability, and bracing design.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5533 Prestressed Concrete**

**Prerequisites:** Graduate standing or admission to CIVE professional school required and CIVE 3523.

**Description:** Design of simple and continuous prestressed concrete beams. Behavior under overload. Calculation of prestress losses and deflections. May not be used for degree credit with CIVE 4533.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5543 Bridge Design**

**Prerequisites:** CIVE 3513 AND CIVE 3523.

**Description:** Structural design of steel and concrete highway bridges, including bridge types, parts of a bridge, loads and load distribution, analysis, design, and bridge rating. Emphasis on topics of special interest to students.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5563 Structural Dynamics**

**Prerequisites:** Graduate standing or admission to CIVE professional school required and ENSC 2123 and CIVE 3413.

**Description:** Analysis of linear, elastic damped and undamped systems with single and multiple degrees of freedom undergoing free and forced vibration. Lumped and distributed mass systems. Computational techniques to numerically integrate the equations of motion. Course previously offered as CIVE 6433.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5573 Timber Design**

**Prerequisites:** Graduate standing or admission to CIVE professional school required and CIVE 3523 or CIVE 3513.

**Description:** Design of structural timber members, assemblies, and connections in accordance with ANSA/AF&PA, NDS specifications. Design, build, and test timber structure.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Graduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

**CIVE 5583 Advanced Construction Materials**

**Prerequisites:** Graduate student.

**Description:** The course addresses advanced topics on fundamental material properties and related design criteria for products commonly used in civil construction: timber and engineered wood products, metals and alloys, polymers and fiber reinforced composites; and glass. The lectures will include material specific topics on: physical, chemical and mechanical properties; fabrication methods; use and applications; standards, testing and quality control measures; selection and design criteria. May not be used for degree credit with CIVE 4583.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5653 Asphalt Materials and Mix Design**

**Prerequisites:** CIVE 3623 or consent of instructor.

**Description:** Principles of asphalt concrete mix design including material characteristics and performance. Evaluation of Hveem and Marshall mix design methods. Asphalt cements, rubberized asphalt polymer asphalts, emulsions, cutbacks, and aggregates. Laboratory sessions focused on the engineering properties of the materials discussed.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 3 Contact: 5

**Levels:** Graduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

**CIVE 5673 Concrete Materials and Mix Design**

**Prerequisites:** Senior or graduate standing.

**Description:** Principles of concrete mix design, including material characteristics, strength and durability requirements, environmental effects and forensic analysis. ACI and PCA mix design procedures. Laboratory on theoretical and practical aspects of concrete technology.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 3 Contact: 5

**Levels:** Graduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

**CIVE 5693 Pavement Design and Analysis**

**Prerequisites:** CIVE 3633 or consent of instructor.

**Description:** Principles of pavement design, including stress analyses, load and environmental effects, and material characteristics. AASHTO, PCA and AI methods of pavement design. Computer methods. Practical aspects of life cycle cost analyses and construction methods.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5713 Soil Mechanics**

**Prerequisites:** CIVE 3713 and CIVE 4711.

**Description:** Application of soil mechanics principles and concepts in geotechnical areas of permeability and seepage, settlement analysis, bearing capacity, lateral earth pressures and retaining walls, slope stability, and metastable soils. May not be used for degree credit with CIVE 4733.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5723 Foundation Engineering**

**Description:** Types of structural foundations including footings, mats, rafts, piles and drilled shafts. Site characteristics, exploration programs, field data, test results and construction materials and methods as basis for selection of type of foundation and design. Geotechnical design procedures and considerations. May not be used for degree credit with CIVE 4723.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5733 Rock Mechanics in Engineering Design and Construction**

**Prerequisites:** Undergraduate courses in soils and geology.

**Description:** Stresses, strength variations, and deformational behavior of rock. Engineering classification of rock. Methods of field and laboratory measurement of the engineering properties of rock. Rock mechanics consideration in the design and construction of engineering works.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5743 Soil-Struc Interaction**

**Description:** The mechanical interaction effects between soils and structures using suitable engineering procedures such as finite differences and finite element methods. Civil engineering problems where interaction effects are most dominant including grade beams (beams on elastic foundation), axially- and laterally-loaded piles, cantilever, and anchored sheet pile walls. May not be used for degree credit with CIVE 4773.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5753 Engineering Soil Stabilization**

**Description:** Theoretical and practical aspects of engineering soil stabilization as a method for improving and upgrading low quality and unstable soils for engineering purposes. Use of lime, fly ash, portland cement, asphalt, and other physical and chemical admixtures. Application of deep foundation stabilization methods such as preloading, deep compaction, injection and reinforcement. May not be used for degree credit with CIVE 4753.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5800 Environmental Engineering Seminar**

**Prerequisites:** Graduate standing and permission of instructor.

**Description:** Course is a seminar series for graduate students in the Environmental Engineering program. Seminars will be given by the students in the course and by guest speakers. Through presentations using logical and evaluations, students will learn a breadth of topics in Environmental Engineering and related fields, and will learn and practice presentation skills.

**Credit hours:** 1-3

**Contact hours:** Lecture: 1-3 Contact: 1-3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5813 Environmental Laboratory Analysis**

**Prerequisites:** Graduate standing or permission of instructor.

**Description:** Analytical procedures for water and waste water contaminants. Emphasis on the chemical theory of procedures, analytical work and an understanding of the significance or need for such laboratory data for surface and groundwater management and water and wastewater treatment processes and design. May not be used for degree credit with CIVE 3853.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 3 Contact: 5

**Levels:** Graduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Civil & Environ. Eng

**CIVE 5823 Environmental Risk Assessment and Management**

**Prerequisites:** Graduate standing or permission of instructor.

**Description:** Environmental risk assessment and management. Applies elements of statistics, probability and environmental simulation to determine the public health and ecological risks from activities of humans. May not be used for degree credit with CIVE 4923.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5833 Introduction to Environmental Modeling**

**Description:** Intended as an introductory course for graduate and senior undergraduate students to the fundamentals of environmental modeling. Develops material necessary to construct models capable of identifying contaminant distributions at future times and space for water and air pollution applications. Advanced topics such as stochastic modeling, ecological risk assessment, neural modeling and spatial statistical analysis among others will be presented according to the backgrounds and interests of the enrolled students. In part, the course is designed as the "Physical Science" component for MS students in the Environmental Sciences program. May not be used for degree credit with CIVE 4883.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5843 Unit Operations in Environmental Engineering**

**Description:** Fundamental principles of water and wastewater treatment, including basic theory and development of design parameters.

Application of these to the design of unit operations and processes in various treatment plans. May not be used for degree credit with CIVE 4833. CIVE 5843 was used to denote Hydrology II prior to 2004.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5853 Bioremediation**

**Prerequisites:** Graduate standing.

**Description:** Science and technologies for the site selection and bioremediation of hazardous contamination in soil, sediment and groundwater systems. Includes geochemical reactions and analysis, pollutant fate and transport modeling, microbial degradation mechanisms, natural attenuation, and measurements of success. Course requires a familiarity with differential equations and basic microbiology. May not be used for degree credit with CIVE 4853.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5863 Advanced Unit Operations in Environmental Engineering**

**Description:** Theory and design of advanced physical-chemical water and wastewater treatment processes applied to municipal, industrial, and hazardous waste situations. May not be used for degree credit with CIVE 4863.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5873 Air Pollution Control Engineering**

**Description:** Causes, effects, and control of atmospheric pollution. Same course as CHE 5873. May not be used for degree credit with CIVE 4873.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5883 Residuals and Solid Waste Management**

**Prerequisites:** Graduate standing or admission to CIVE professional school required, or permission of instructor.

**Description:** Theory, design and operation of systems for handling, treatment, and disposal of process sludge (water treatment, wastewater treatment, industrial) and solid wastes. Potential material reclamation options. May not be used for degree credit with CIVE 4983.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5903 Microbiology for Engineers**

**Description:** Microbiology relates to many aspects of engineering, primarily environmental engineering. The class will cover the roles of bacteria in water and wastewater treatment, the bioremediation of hazardous substances, the mechanisms of antibiotic resistance, the molecular tools for studying and tracking bacteria, and special topics with regards to bacteria in common engineered environments. Basic microbiology and biochemistry will be covered throughout the course providing necessary background. May not be used for degree credit with CIVE 4903.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5913 Groundwater Hydrology**

**Prerequisites:** Graduate standing or admission to CIVE professional school required and 3843, or permission of instructor.

**Description:** Theory of groundwater movement, storage, exploration and pumping tests. Design of groundwater recovery and recharge systems.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5933 Water Treatment**

**Description:** Theory, design, and operation of water treatment plants. Sizing of various unit processes. Water treatment plant control procedures. May not be used for degree credit with CIVE 4933.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5953 Biological Waste Treatment**

**Description:** Fundamentals of microbial systems applied to waste treatment processes. Standard suspended-growth and fixed biofilm wastewater and sludge suspensions and treatment system design calculations. May not be used for degree credit with CIVE 4953.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 5963 Open Channel Flow**

**Prerequisites:** Graduate standing or admission to CIVE professional school required and CIVE 3833, or permission of instructor.

**Description:** Open channel hydraulics, energy and momentum concepts, resistance, channel controls and transitions, flow routing, and sediment transport.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 6000 PhD Research Dissertation**

**Description:** Independent research under the direction of a member of the graduate faculty by students working beyond the level of Master of Science degree. Offered for variable credit, 1-16 credit hours, maximum of 30 credit hours.

**Credit hours:** 1-16

**Contact hours:** Contact: 1-16 Other: 1-16

**Levels:** Graduate

**Schedule types:** Independent Study

**Department/School:** Civil & Environ. Eng

**CIVE 6010 Seminar**

**Prerequisites:** Consent of instructor and approval of the student's advisory committee.

**Description:** Analytical studies with suitable reports on problems in one or more of the subfields in civil engineering by students working beyond the level of Master of Science degree. Offered for variable credit, 1-6 credit hours, maximum of 12 credit hours.

**Credit hours:** 1-6

**Contact hours:** Contact: 1-6 Other: 1-6

**Levels:** Graduate

**Schedule types:** Independent Study

**Department/School:** Civil & Environ. Eng

**CIVE 6403 Theory of Elasticity**

**Prerequisites:** Graduate standing or admission to CIVE professional school required, or permission of instructor.

**Description:** Stress, strain, and deformation analysis of two- and three-dimensional elastic continua. Propagation of stress waves through elastic continua.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 6413 Plate and Shell Structures**

**Prerequisites:** Graduate standing or admission to CIVE professional school required and CIVE 5403, or permission of instructor.

**Description:** Bending of thin plate structures to include rectangular and circular plates. Analysis of orthotropic plates by classical and numerical methods. Introduction to shell bending theory.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng



**CIVE 6434 Finite Element Analysis**

**Prerequisites:** Graduate standing and permission of instructor.

**Description:** Finite elements: formulation techniques, weighted residuals, variational techniques, shape functions and element types, isoparametric elements, convergence criteria, error analysis, and programming techniques. Applications to solid mechanics, structures, fluid mechanics, and heat transfer are discussed.

**Credit hours:** 4

**Contact hours:** Lecture: 4 Contact: 4

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 6553 Natural Hazards Engineering**

**Prerequisites:** Graduate standing and CIVE 5563.

**Description:** Performance of structural systems exposed to extreme loadings from natural hazard events. The response, analysis, and design of structures exposed to earthquakes, wind, flood, and fire loadings are considered. Advanced analytical, computational, and experimental techniques. Current building code specifications.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 6843 Stochastic Methods in Hydrology**

**Prerequisites:** Graduate standing and STAT 4073 or STAT 4033.

**Description:** Stochastic and statistical hydrologic analyses of surface water and ground water systems. Analyses of urban and rural drainage and detention systems. Same course as BAE 6313.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng

**CIVE 6923 Industrial Wastes Engineering**

**Prerequisites:** Graduate standing or permission of instructor.

**Description:** Theory and methods of waste minimization, waste product reduction or reuse; process changes and treatment of residuals to reduce volume and toxicity of industrial wastes.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Civil & Environ. Eng