

# CIVIL ENGINEERING (CE)

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## CE Courses

### CE 111. Introduction to Civil Engineering. 1 unit

Term Typically Offered: F

CR/NC

Broad overview of the field of civil engineering, including professional societies and their student chapters, professional licensing and registration, professional codes of ethics, the elements of engineering design, and the scope of analysis and design activities undertaken by private- and public-sector civil design professionals. Credit/No Credit grading only. 1 lecture.

### CE 112. Design Principles in Civil Engineering. 2 units

Term Typically Offered: W

Brief introduction to the different technical areas of civil engineering, including engineering design process, basic design principles and failure scenarios, professionalism and licensing in Civil Engineering. 2 lectures.

### CE 113. Computer Aided Drafting in Civil Engineering. 2 units

Term Typically Offered: F, W, SP

Computer-aided drawing (CAD) and related software to display and quantify engineering designs. Elements of engineering design drawings. Related topics in information technology. Course may be offered in classroom-based or online format. 2 laboratories.

### CE 200. Special Problems. 1-2 units

Term Typically Offered: F, W, SP

CR/NC

Prerequisite: Consent of department chair.

Individual investigation, research, studies, or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter. Credit/No Credit grading only.

### CE 204. Mechanics of Materials I. 3 units

Term Typically Offered: F, W, SP

Prerequisite: ME 211.

Stresses, strains, and deformations associated with axial, torsional, and flexural loading of bars, shafts, and beams. Analysis of elementary determinate and indeterminate mechanical and structural systems. 2 lectures, 1 activity.

### CE 207. Mechanics of Materials II. 2 units

Term Typically Offered: F, W, SP

Prerequisite: CE 204.

Combined stress states including torsion, axial, shear, moment, and pressure vessel loadings. Principle stress/strain states. Basic failure criteria. Analysis of beam forces, moments, deflections, and rotations. Introduction to stability concepts including column buckling. 1 lecture, 1 activity.

### CE 208. Mechanics of Materials. 5 units

Term Typically Offered: F, W

Prerequisite: ME 211.

Stresses, strains, and deformations associated with axial, torsional, and flexural loading of bars, shafts, and beams. Combined stress states including torsion, axial, shear, moment, and pressure vessel loadings. Principle stress/strain states and basic failure criteria. Stability concepts including column buckling. Not open to students with credit in CE 204. 3 lectures, 2 laboratories.

### CE 222. Introductory Experiments in Transportation Engineering. 1 unit

Term Typically Offered: F, W, SP

Application of urban transportation planning, design, and operations principles. Introduction to Engineering Economics in the context of transportation projects. Collect field traffic operations data and conduct analysis and report conclusions from collected data. Field trip required. 1 laboratory.

### CE 251. Programming Applications in Engineering. 2 units

Term Typically Offered: F, W, SP

Prerequisite: CE 113; MATH 244; and CE 204 or CE 208 (CE 208 may be taken concurrently).

Concepts from basic programming theory introduced in the context of engineering applications. Topics include the application of programming constructs to demonstrate finite precision calculations, linear systems, linear programming, basic nonlinear systems, plotting, statistics, least squares, approximations, and solve related problems from civil and environmental engineering. 2 activities.

### CE 259. Civil Engineering Materials. 2 units

Term Typically Offered: F, W, SP

Prerequisite: CE 204 or CE 208 (CE 208 may be taken concurrently).

Corequisite: CE 113.

Experimental determination of mechanical properties of concrete, asphalt, and soils as required for engineering applications. Experimental verification of assumptions made in mechanics of materials procedures. Use of strain measuring devices. Preparation of technical reports. 2 laboratories.

### CE 270. Selected Topics. 1-4 units

Term Typically Offered: TBD

Prerequisite: Open to undergraduate students and consent of instructor.

Directed group study of selected topics. The Class Schedule will list topic selected. Total credit limited to 8 units. 1 to 4 lectures.

### CE 321. Fundamentals of Transportation Engineering. 3 units

Term Typically Offered: F, W, SP

Sustainability Related

Prerequisite: PHYS 141; CE 259 or CM 113; or graduate standing.

The characteristics and functions of highway, air, rail, transit and other modes of urban and intercity transportation. Fundamentals of transportation design, operations, and planning. Evaluation of costs, benefits, and environmental considerations. 3 lectures.

**CE 322. Fundamentals of Transportation Engineering Laboratory. 1 unit**

Term Typically Offered: F, W, SP

Prerequisite: CE 222. Corequisite: CE 321.

Application of urban transportation planning and operations principles and the design of highway facilities. Experimentation with properties of pavement materials through laboratory/field testing as well as preparation of testing reports. Field trip required. 1 laboratory.

**CE 336. Water Resources Engineering. 4 units**

Term Typically Offered: F, W, SP

Sustainability Related

Prerequisite: ME 341 or ENVE 264. Concurrent: CE 337.

Hydraulics of pile flow. Open channel flow, groundwater, and hydrology. 4 lectures.

**CE 337. Hydraulics Laboratory. 1 unit**

Term Typically Offered: F, W, SP

Prerequisite: ME 341 or ENVE 264. Concurrent: CE 336.

Application of basic fluid dynamic principles to various mechanical systems. Exposure to experimental problems and techniques with guided laboratory projects related to civil engineering discipline. 1 laboratory.

**CE 352. Structural Engineering. 4 units**

Term Typically Offered: F, W, SP

Prerequisite: CE 207 or CE 208. Corequisite: CE 251.

Introduction to concepts of structural engineering including ASCE7 loads, vertical and lateral load path, flexible and rigid diaphragms, determinate vs indeterminate systems, and the use of computer programs to solve structural engineering problems. 3 lectures, 1 laboratory.

**CE 355. Reinforced Concrete Design. 4 units**

Term Typically Offered: F, W, SP

Prerequisite: CE 259 and CE 352.

Analytical and design principles of reinforced concrete in designing civil engineering systems. Origin of code requirements. Fundamentals of proportioning. Details of elements and structural systems. 3 lectures, 1 laboratory.

**CE 356. Structural Steel Design. 4 units**

Term Typically Offered: F, SP

Prerequisite: CE 352.

Design and behavior of the elements of steel structures. Design and analysis of bolted, welded and eccentric connections. Proportioning of members and connections. Introduction to plastic design, end plate connection, composite construction, shear connections and design of composite beams. 3 lectures, 1 laboratory.

**CE 371. Construction Management and Project Planning. 4 units**

Term Typically Offered: F, W, SP

Prerequisite: ARCE 106, CE 259 or CM 113.

Theory and practice of planning, scheduling, estimating, and reporting for construction projects. Fundamentals of scheduling logic including critical path, deterministic, and probabilistic scheduling; including the impact of constraints. Identifying resources and estimating time requirements for design activities and project operations. Not open to Architectural Engineering or Construction Management majors. 3 lectures, 1 activity. Crosslisted as CE/CM 371.

**CE 381. Geotechnical Engineering. 4 units**

Term Typically Offered: F, W, SP

Prerequisite: CE 207 or CE 208; ME 341 or ENVE 264. Concurrent: CE 382 (CE majors only).

Engineering geology, elementary mass-volume relations, clay-water interaction, soil classification, soil compaction, geostatic stress distributions, 1-D and 2-D steady-state flow, shear strength under drained and undrained conditions. 4 lectures.

**CE 382. Geotechnical Engineering Laboratory. 1 unit**

Term Typically Offered: F, W, SP

Corequisite: CE 381.

Use of standard laboratory test methods to determine physical, mechanical, and hydraulic properties of soil. 1 laboratory.

**CE 400. Special Problems. 1-2 units**

Term Typically Offered: F, W, SP

Prerequisite: Consent of department chair.

Individual investigation, research, studies, or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter.

**CE 403. Civil Engineering Design Competition. 1 unit**

Term Typically Offered: F, W, SP

Prerequisite: CE 207 or CE 208.

Design, build, test, and present a solution to a civil engineering problem posed by a student design competition. Total credit limited to 4 units. 1 laboratory.

**CE 404. Applied Finite Element Analysis. 4 units**

Term Typically Offered: F

Prerequisite: BMED 410, and CE 207 or CE 208; or CE 406; or ME 328.

Finite element based solutions to engineering problems with an emphasis on elastostatic problems in structural mechanics. The power and pitfalls associated with the finite element method highlighted through practical modeling assignments. Introduces the use of commercial finite element codes. 3 lectures, 1 laboratory. Crosslisted as BMED/CE/ME 404.

**CE 406. Structural Analysis. 5 units**

Term Typically Offered: F

Prerequisite: CE 352.

Structural analysis of frames, trusses, and combined systems. Modern structural analysis theorems are presented along with discussion of their relation to classical methods. Specific topics include virtual forces, virtual displacements, compatibility, constraints and matrix formulations. Course may be offered in classroom-based or online format. 4 lectures, 1 laboratory.

**CE 407. Structural Dynamics. 4 units**

Term Typically Offered: W

Prerequisite: CE 406 and ME 212.

Effect of vibration and transient loads on structural elements. Dynamics load factors, support motion, damping and natural frequencies of multidimensional structural systems. Modal analysis. 3 lectures, 1 laboratory.

**CE 413. Advanced Civil Computer-Aided Site Design. 2 units**

Term Typically Offered: F, W

Prerequisite: BRAE 239; CE 113 or CM 115; and CE 321.

Apply advanced CAD software to develop design techniques and convey the completed design on a set of plans; site coordination, basic road design, grading, and utility design. Course may be offered in classroom-based or online format. 2 laboratories.

**CE 415. Advanced Building Information Modeling for Civil Engineering. 4 units**

Term Typically Offered: F, W

Prerequisite: CE/CM 371.

Building Information Modeling (BIM) approach to design, optimize, construct, and manage vertical structures. BIM based quantity take-off, clash detection, 4D modeling, and reality capturing using a 3D laser scanner. Course may be offered in classroom-based or online format. 2 lectures, 2 laboratories.

**CE 421. Traffic Engineering. 4 units**

Term Typically Offered: F, W

Prerequisite: CE 321.

Principles of traffic circulation on highway systems and other modes. Traffic control. Traffic data collection and analysis. Capacity analysis. Traffic modeling. New technologies. 3 lectures, 1 laboratory.

**CE 422. Highway Geometrics and Design. 4 units**

Term Typically Offered: W

Prerequisite: CE 321.

Alignment location and safe geometric design of highways. Earthwork and drainage related to highway. Theory and practice in design of alignments, highway cross-sections, intersections, interchanges, and freeways in urban and rural areas. Application of advanced computer software to highway geometrics. 2 lectures, 2 laboratories.

**CE 423. Intelligent Transportation Systems. 4 units**

Term Typically Offered: SP

Prerequisite: CE 321 or graduate standing.

Specification and operation of Intelligent Transportation Systems (ITS). Traffic surveillance and control systems including applications to freeways, urban streets, rural highways, and public transportation. Standards include the National Architecture for ITS. 3 lectures, 1 laboratory.

**CE 424. Public Transportation. 4 units**

Term Typically Offered: W

Sustainability Related

Prerequisite: CE 321.

Interdisciplinary aspects of public transportation problems, systems-team design approach to solutions. History and present state of public transportation; role of public transportation in urban environment; legislative, political, social, and economic aspects of public transportation systems. Methodology and procedures for transit planning. Review of transit studies. 3 lectures, 1 laboratory.

**CE 425. Introduction to Railway Engineering. 4 units**

Term Typically Offered: SP

Prerequisite: CE 321.

Introduction to railroad and railway system analysis and design. Railroads, rail transit and high speed rail applications. Track foundation design for various conditions. Approaches to railway analysis and design and an introduction to railway traffic control and signaling. 4 lectures.

**CE 429. Highway Pavement Designs. 4 units**

Term Typically Offered: F, SP

Prerequisite: CE 259 or CM 113; CE 381 or ARCE 421; and CE 321.

Theories, principles, and procedures in the structural design of highway pavements. Design of flexible and rigid pavements. Performance of flexible and rigid pavements in the field and the characterization of pavement materials. Practical and direct exposure to laboratory testing of pavement materials. 3 lectures, 1 laboratory. Formerly CE 521.

**CE 431. Coastal Hydraulics I. 4 units**

Term Typically Offered: W

Prerequisite: ME 341 or ENVE 264.

Waves and their characteristics, types of waves, water wave theories, orbital velocities, refraction of waves, wave diffraction, wave reflection, application of linear theory to wave forces on cylindrical structures, submerged pipelines and vertical flat barriers (sea walls), wave uprush, rubble mound breakwaters. 4 lectures.

**CE 432. Coastal Hydraulics II. 4 units**

Term Typically Offered: SP

Prerequisite: CE 431.

Reformed breaker height determination, wave runup analysis using a reformed breaker height. Wave setback analysis. Pile height determination. Criteria for types of breaking waves. Revetment analysis, rip-rap revetment design, wave forces on pilings. 4 lectures.

**CE 433. Open Channel Hydraulics. 4 units**

Term Typically Offered: F

Prerequisite: CE 336.

Analysis and characteristics of flow in open channels; critical flows; uniform flow; gradually varied flow; channel design problems, channel transitions and controls. Rapidly varied flow; hydraulic jump and energy dissipaters. Unsteady flows, waves and wave propagation, flood routing. Applications of numerical methods in hydraulic engineering. 4 lectures.

**CE 434. Groundwater Hydraulics and Hydrology. 4 units**

Term Typically Offered: W, SP

Prerequisite: CE 336.

Differential equations of groundwater flow, Darcy's Law, solutions of the steady and unsteady flow, differential equations for confined and unconfined flows. Pumping test design. Groundwater models, leaky aquifers. Saltwater intrusion. 4 lectures.

**CE 435. Engineering Hydrology. 4 units**

Term Typically Offered: F  
Prerequisite: CE 336.

Analysis of hydrologic cycle components such as precipitation, infiltration and evaporation. Rainfall-runoff analysis to determine peak flows and runoff hydrographs. Hydrologic river and reservoir routings and their applications for flood plain management. Application of frequency analysis methods to determine design rainfalls and design flows. 4 lectures.

**CE 436. Heavy Civil Temporary Structures and Shoring. 4 units**

Term Typically Offered: W  
Prerequisite: ARCE 315 or CE 352; and CM 314.

Design and construction of retaining walls, concrete formwork, falsework, scaffolding, ramps, platform, bracing, and guying as applied to heavy civil projects. Field trip may be required. 2 lectures, 2 laboratories. Crosslisted as CE/CM 436.

**CE 437. Heavy Civil Projects and Equipment. 4 units**

Term Typically Offered: SP  
Prerequisite: CM 314.

Heavy civil projects logistics, construction, operations, planning, management, workflow and sequencing, equipment management, fleet configuration and maintenance, equipment productivity and cost optimization. 2 lectures, 2 laboratories. Crosslisted as CE/CM 437.

**CE 440. Hydraulic Systems Engineering. 4 units**

Term Typically Offered: F, W  
Prerequisite: CE 336.

Water and wastewater flows. Design of water distribution systems, transmission and storage reservoirs, wastewater collection systems, and storm water systems. Pumps and pump systems, flow measurements. Water sources for municipal supply. 3 lectures, 1 laboratory.

**CE 454. Integrated Structural Design. 4 units**

Term Typically Offered: W  
Prerequisite: CE 355, CE 356, and CE 455.

Structural analysis and integrated system design of reinforced concrete, concrete block masonry, structural steel, and timber structures. Loading standards, code design methods, connection design. Comprehensive design projects. 2 lectures, 2 laboratories.

**CE 455. Design of Timber Structures. 4 units**

Term Typically Offered: F  
Prerequisite: CE 352.

Analysis and design of timber structures with emphasis on construction methodology, and material behavior. Topics include physical and mechanical properties of structural lumber and glued laminated timber; lateral load paths; diaphragms; connections; shear wall design; and combined load design. 3 lectures, 1 activity.

**CE 457. Bridge Engineering. 4 units**

Term Typically Offered: SP  
Prerequisite: CE 355. Corequisite: CE 356.

Fundamentals of the structural analysis and design of highway bridges. Construction materials in bridges. Loads on highway bridges. Load path and distribution in bridge superstructure. Design of reinforced concrete, pre-stressed concrete, and composite bridges. 3 lectures, 1 laboratory.

**CE 459. FRP Strengthening of Reinforced Concrete Structures. 4 units**

Term Typically Offered: TBD  
Prerequisite: CE 355.

Flexural and shear strengthening reinforced and prestressed concrete members using fiber reinforced polymer composite plates and laminates; seismic repair and rehabilitation of columns, slabs, beams and structures. Focus on design philosophy and design methodology, based on the current understanding of FRP-strengthening techniques. Not open to students with credit in CE 556. 3 lectures, 1 laboratory.

**CE 465. Civil Engineering Professional Practice. 1 unit**

Term Typically Offered: F  
Prerequisite: Senior standing and consent of instructor.

Advising for Senior Design Project and examination of the non-technical and professional issues engineering design professionals regularly encounter. Topics include: communications styles and assertiveness, technical communications (oral and written), lifelong learning, contemporary civil engineering issues, leadership, ethics, and personal and project management. Course may be offered in classroom-based or online format. 1 activity.

**CE 466. Senior Design Project I. 3 units**

Term Typically Offered: W  
Prerequisite: CE 321, CE 322, CE 336, CE 337, CE 355, CE 371, CE 381, CE 382, and CE 465.

Work on multi-disciplinary teams to complete an integrated civil design project. Focus on formal instruction, through project based learning, on selected topics in geotechnical, structural, transportation, and water resources engineering design. Non-technical topics include team building, technical communications, and professional practice skills that must be mastered to become a successful design professional. 2 lectures, 1 laboratory.

**CE 467. Senior Design Project II. 3 units**

Term Typically Offered: SP  
Prerequisite: CE 466.

Continuation of work on multi-disciplinary teams to complete an integrated civil design project started in CE 466. Focus of formal instruction on selected topics in construction, geotechnical, structural, transportation, and water resources engineering design culminating with oral and written presentations of Senior Design projects. 2 lectures, 1 laboratory.

**CE 470. Selected Advanced Topics. 1-4 units**

Term Typically Offered: TBD  
Prerequisite: Consent of instructor.

Directed group study of selected topics for advanced students. Open to undergraduate and graduate students. The Class Schedule will list topic selected. Total credit limited to 8 units. 1 to 4 lectures.

**CE 471. Selected Advanced Laboratory. 1-4 units**

Term Typically Offered: TBD  
Prerequisite: Consent of instructor.

Directed group laboratory study of selected topics for advanced students. Open to undergraduate and graduate students. The Class Schedule will list topic selected. Total credit limited to 8 units. 1 to 4 laboratories.

**CE 474. Environmental Compliance and Permitting. 2 units**

Term Typically Offered: W  
Prerequisite: Senior standing.

Fundamentals of State and Federal environmental laws essential to getting Civil Engineering projects permitted. 2 lectures.

**CE 475. Civil Infrastructure and Building Systems. 4 units**

Term Typically Offered: F, W  
Sustainability Focused  
Prerequisite: Senior standing in CE or ARCE.

Principles and practices for the sustainable design, fabrication, and installation of systems for the civil infrastructure and building; including structural, air/gas, water/wastewater, electrical, and control systems. Methods and materials used for fabrication and installation; including cost and schedule considerations. 4 lectures. Crosslisted as ARCE/CE 475.

**CE 481. Analysis and Design of Shallow Foundations. 4 units**

Term Typically Offered: F, W, SP  
Prerequisite: CE 381 and CE 382.

Evaluation of shear strength for foundation design. Analysis of bearing capacity for generalized conditions. Design of reinforced concrete spread footings. Stress distributions beneath loaded areas. Immediate settlement, consolidation settlement, rate of consolidation, and creep. 4 lectures.

**CE 486. Introduction to Geological Engineering. 4 units**

Term Typically Offered: W  
Prerequisite: CE 381, CE 382, and GEOL 201.

Identification and characterization of consolidated geologic materials for the purpose of civil analysis and design. Interpretation of geologic maps, cross sections, and reports. Interpretation of aerial photographs. Engineering considerations important in dealing with transported soils. 4 lectures.

**CE 488. Engineering Risk Analysis. 4 units**

Term Typically Offered: F  
Prerequisite: Senior standing and STAT 312; or graduate standing.

Introduction to the basic concepts of probability theory, statistics, and decision theory as they pertain to problems in civil and environmental engineering. Emphasis placed on the use of probabilistic modeling, Bayesian statistics, risk analysis, and decision theory. 4 lectures.

**CE 493. Cooperative Education Experience. 2 units**

Term Typically Offered: TBD  
CR/NC  
Prerequisite: Sophomore standing and consent of instructor.

Part-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Credit/No Credit grading only. No major credit allowed; total credit limited to 6 units.

**CE 494. Cooperative Education Experience. 6 units**

Term Typically Offered: TBD  
CR/NC  
Prerequisite: Sophomore standing and consent of instructor.

Full-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Credit/No Credit grading only. No major credit allowed; total credit limited to 18 units.

**CE 495. Cooperative Education Experience. 12 units**

Term Typically Offered: TBD  
CR/NC  
Prerequisite: Sophomore standing and consent of instructor.

Full-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. A more fully developed formal report and evaluation by work supervisor required. Credit/No Credit grading only. No major credit allowed; total credit limited to 24 units.

**CE 500. Individual Study. 1-3 units**

Term Typically Offered: F, W, SP  
Prerequisite: Consent of department chair, graduate advisor and supervising faculty member.

Advanced study planned and completed under the direction of a member of the department faculty. Open only to graduate students who have demonstrated ability to do independent work. Enrollment by petition. Total credit limited to 4 units.

**CE 501. Advanced Matrix Analysis of Structures. 4 units**

Term Typically Offered: F  
Prerequisite: CE 406.

Matrix terminology and operations. Matrix procedures for analysis of two-dimensional frameworks. Development of stiffness, flexibility and mixed methods. Development of algorithms and programs for use in the analysis of structural frameworks. Discussion of modeling issues and limitations. 3 lectures, 1 laboratory.

**CE 504. Finite Element Analysis. 4 units**

Term Typically Offered: SP  
Prerequisite: CE/ME 404 and CE 511/ME 501 or consent of instructor.

Finite element theory and application with a focus on computer implementation of the method. Strong, weak and variational formulations, physical and isoparametric spaces, error estimates, numerical integration, finite element algorithms, and programming architecture. 3 lectures, 1 laboratory. Crosslisted as CE/ME 504.

**CE 511. Continuum Mechanics and Elasticity. 4 units**

Term Typically Offered: TBD  
Prerequisite: Graduate standing.

Introduction to continuum mechanics. Kinematics, stress, and balance laws. Constitutive theory for isotropic and anisotropic solids and viscous fluids. Applications including design of beams and pressure vessels, stress concentrations, fiber-reinforced composites, and non-homogeneous biological materials. Course offered in hybrid format with classroom-based and online learning. 4 lectures. Crosslisted as CE 511/ME 501.

**CE 513. Inelastic Stress Analysis. 4 units**

Term Typically Offered: TBD

Prerequisite: ME 501 or CE 511.

Perfectly plastic and work hardening materials; von Mises and Tresca yield, isotropic and kinematic hardening flow rules, boundary-value problems. Finite elasticity: kinematics, Cauchy- and Green-elasticity, invariance, constraints, Neo-Hookean and Mooney-Rivlin materials, experimental approaches, non-uniqueness, anisotropy, residual stress, thermoelasticity, boundary-value problems. Course offered in hybrid format with classroom-based and online learning. 4 lectures. Crosslisted as CE 513/ME 503.

**CE 523. Transportation Systems Planning. 4 units**

Term Typically Offered: F

Sustainability Related

Prerequisite: CE 321 or graduate standing.

Planning of urban and regional multimodal transportation systems. Modeling of transportation networks and travel demand. Travel survey design. Urban data systems. Evaluation of alternatives based on economic, social, technological, and other factors. 2 lectures, 2 laboratories.

**CE 525. Airport Planning and Design. 4 units**

Term Typically Offered: TBD

Prerequisite: CE 321 or graduate standing.

Historical background of aviation and airport development; financing; estimating demand; aircraft characteristics; airport capacity; airspace and air traffic control; site selection; airport configuration; geometric design of landing area; planning and development of terminal areas; lighting; pavement design and drainage. 3 lectures, 1 laboratory.

**CE 526. Transportation Safety. 4 units**

Term Typically Offered: W

Prerequisite: CE 321, CE 322, STAT 312.

Introduction to nature and extent of transportation safety problem worldwide and in the United States. Several sub-areas of transportation safety: road safety, human factors, vehicle safety; crash data collection and management; safety planning; hot spot identification; methodologies for conducting transportation accident studies; statistical applications to accident data; predictive model building; "before-after" studies; countermeasure design. 3 lectures, 1 laboratory.

**CE 527. Sustainable Mobility. 4 units**

Term Typically Offered: SP

Sustainability Focused

Prerequisite: CE 321 or CRP 435 or consent of instructor.

Presentation and analysis of concepts and designs for sustainable mobility from a global-to-local, interdisciplinary perspective, including pedestrians, bicyclists, and public transportation. Addresses economy, environment, and equity (social issues) through lectures, panels, excursions and a planning/design project in San Luis Obispo County. 3 lectures, 1 laboratory.

**CE 528. Transportation Economics and Analysis. 4 units**

Term Typically Offered: TBD

Prerequisite: CE 321 or graduate standing.

Principles of engineering systems analysis and applications to transportation using examples from different modes. Identification of transportation benefits, costs, user and non-user impacts, transportation cost models, pricing, and optimization. 3 lectures, 1 laboratory.

**CE 529. Modeling and Simulation in Transportation. 4 units**

Term Typically Offered: SP

Prerequisite: CE 321 or graduate standing.

Theory and operation of transportation systems, the systems approach, simulation techniques. Use of available software packages. Simulation model development, calibration and use. 2 lectures, 2 laboratories.

**CE 533. Advanced Water Resources Engineering. 4 units**

Term Typically Offered: SP

Prerequisite: CE 336 or graduate standing.

Matrix and simulation methods in hydrology, statistical studies in hydrology and their applications to civil engineering problems. Generalized hydrologic characteristics. Hydrologic simulation, computer applications, urban and small watershed hydrology, macroscopic and microscopic approach. Storm water management models. Hydrologic design. 4 lectures.

**CE 536. Computer Applications in Water Resources with Geographic Info Systems (GIS). 4 units**

Term Typically Offered: W

Prerequisite: CE 336 or graduate standing.

Modeling, design and analysis of water, wastewater, stormwater systems. Integration of water resource systems with Geographic Information Systems (GIS). 3 lectures, 1 laboratory.

**CE 537. Groundwater Contamination. 4 units**

Term Typically Offered: F

Prerequisite: CE 434. Corequisite: ENVE 331.

Sources and types of groundwater contamination, contamination transport mechanisms. Sorption and other chemical reactions. Numerical modeling of contaminant transport. Nonaqueous phase liquids. Groundwater remediation and design. 4 lectures.

**CE 538. Urban Water Systems. 4 units**

Term Typically Offered: SP

Prerequisite: CE 440 or graduate standing.

Integration of water delivery, wastewater collection, drainage systems, and associated treatment components in urbanizing areas. Relationships between surface and groundwater elements of water sources and disposal. Use of current design models to quantify the benefits of non-traditional options. 4 lectures.

**CE 539. Environmental Hydraulics. 4 units**

Term Typically Offered: W

Prerequisite: CE 336 or graduate standing.

Application of fluid mechanics principles to environmental flows. Emphasis on advection, dispersion, stratification and mixing effects. Stratified flows, turbulent jets and plumes, wastewater and thermal diffusers, cooling ponds and channels, control of environmental problems. 4 lectures.

**CE 552. Analysis and Seismic Design of Reinforced Concrete. 4 units**

Term Typically Offered: TBD

Prerequisite: CE 454. Recommended: Concurrent enrollment in CE 557.

Emphasis placed on reinforced concrete behavior and seismic design. Topics include moment curvature analysis and plastic hinge modeling, strut and tie, design of structural walls, design of concrete moment frames and seismic detailing. 4 lectures.

**CE 553. Ductile Design of Steel Structures. 4 units**

Term Typically Offered: W

Prerequisite: CE 356 and senior or graduate standing. Recommended: CE 454 and CE 407.

Plastic analysis and capacity design principle; design of ductile steel structures including moment frames, concentrically braced frames, eccentrically braced frames, buckling-restrained braced frames, and steel plate shear walls according to the AISC Seismic Provisions for Structural Steel Buildings. 3 lectures, 1 activity.

**CE 555. Advanced Civil Engineering Materials Laboratory. 2 units**

Term Typically Offered: F

Prerequisite: CE 259 or graduate standing.

Fundamental properties of new and advanced materials. Experimental techniques. Fracture characteristics and composite response of cement matrix composites. New materials and products to advanced applications such as automation. 2 laboratories.

**CE 556. Advanced Fiber Reinforced Polymer (FRP) Strengthening of Reinforced Concrete Structures. 4 units**

Term Typically Offered: W

Prerequisite: CE 355.

Flexural and shear strengthening reinforced and pre-stressed concrete members using FRP composite laminates and plates; seismic repair and rehabilitation of columns, beams, slabs and whole structures. Design philosophies based on the current ACI 440 and the most up to date research in FRP composites. Durability, fire protection and blast mitigation of structures utilizing FRP laminates. Not open to students with credit in CE 459. 3 lectures, 1 laboratory.

**CE 557. Seismic Analysis and Design. 4 units**

Term Typically Offered: SP

Prerequisite: CE 407.

Extension of the basic principles of structural dynamics to analysis of civil structures and nonstructural components to earthquake loading. Code based (ASCE/SEI 7) earthquake resistant design. 3 lectures, 1 laboratory.

**CE 559. Prestressed Concrete Design. 4 units**

Term Typically Offered: SP

Prerequisite: CE 355 or graduate standing.

Advanced analysis, design and behavior of prestressed and precast concrete elements and structures. Origin of code requirements. Detailed design of prestressed concrete components of civil engineering systems for buildings and highway construction. Creep and shrinkage of concrete and relaxation of steel applied to prestressing losses. 4 lectures.

**CE 570. Selected Advanced Topics. 1-4 units**

Term Typically Offered: TBD

Prerequisite: Graduate standing or consent of instructor.

Directed group study of selected topics for advanced students. Open to graduate students. The Class Schedule will list topic selected. Total credit limited to 8 units. 1 to 4 seminars.

**CE 571. Selected Advanced Laboratory. 1-4 units**

Term Typically Offered: TBD

Prerequisite: Graduate standing or consent of instructor.

Directed group laboratory study of selected topics for advanced students. Open to undergraduate and graduate students. The Class Schedule will list topic selected. Total credit limited to 8 units. 1 to 4 laboratories.

**CE 572. Engineering Project Management. 4 units**

Term Typically Offered: W

Prerequisite: CE 465.

Principles and techniques of managing projects from conceptual phase through project definition, design and construction, to closeout. Emphasis on project management aspects of scope definition, estimates and budgeting, control systems, procurement, design coordination, construction phases, and leadership skills. 3 lectures, 1 laboratory.

**CE 581. Advanced Geotechnical Engineering. 4 units**

Term Typically Offered: SP

Prerequisite: CE 481 or graduate standing.

Advanced topics in saturated flow, unsaturated flow, and consolidation. Stress-strain-deformation response of soils under both drained and undrained loading. Conventional and advanced laboratory strength testing. 3 lectures, 1 laboratory.

**CE 583. Geotechnical Earthquake Engineering. 4 units**

Term Typically Offered: SP

Prerequisite: CE 481 or graduate standing.

Introduction to engineering seismology and ground motion evaluation. Dynamic behavior of soils. Seismic site response analysis. Soil liquefaction evaluation methods and mitigation techniques. Seismic stability of slopes and retaining walls. Computer-aided analysis. 4 lectures.

**CE 584. Lateral Support Systems. 4 units**

Term Typically Offered: TBD

Prerequisite: CE 481 or graduate standing.

Classical and modern earth pressure theories. Lateral earth pressure calculations for general subsurface conditions. Analysis and design of reinforced concrete cantilever walls, sheetpile walls, soldier-pile walls, tie-back walls, and mechanically-stabilized earth. Computer-aided analysis and design. 4 lectures.

**CE 585. Slope Stability Analysis. 4 units**

Term Typically Offered: TBD

Prerequisite: CE 481 or graduate standing.

Analysis of stability by planar, circular arc, piecewise-linear, and composite-surface techniques. Analysis of earth-fill dams and reservoirs for static, steady flow, sudden drawdown, and seismic loading conditions. Field instrumentation. Methods for slope remediation and stabilization. Computer-aided analysis. 4 lectures.

**CE 586. Analysis and Design of Deep Foundations. 4 units**

Term Typically Offered: W

Prerequisite: CE 481 or graduate standing.

Bearing capacity and settlement analysis of drilled shafts and driven piles. Analysis and design of single piles and pile groups for vertical, lateral, and combined loading. Construction procedures, field inspection, and load-testing. Computer-aided analysis and design. 4 lectures.

**CE 587. Geoenvironmental Engineering. 4 units**

Term Typically Offered: SP

Prerequisite: CE 381.

Principles for containment applications. Engineering properties of soils and geosynthetics and their interaction with contaminants and wastes; analysis of geosynthetics used in containment facilities; liners; covers; leachate and gas collection systems; contaminant transport; and monitoring systems. 4 lectures.

**CE 588. Ground Improvement. 4 units**

Term Typically Offered: TBD

Prerequisite: CE 381, CE 382, and CE 481.

Ground improvement applications investigated for modification of geomechanical and hydraulic properties of soils. Engineering properties of soft ground and high water content materials; mechanical, chemical, and thermal stabilization investigated for foundation and environmental remediation applications. 4 lectures.

**CE 589. Geosynthetics Engineering. 4 units**

Term Typically Offered: TBD

Prerequisite: CE 481.

Geosynthetics applications within civil engineering. Design content for geotechnical, geoenvironmental, and transportation applications. Manufacturing processes, material properties, interaction with soils, and service conditions. 4 lectures.

**CE 591. Graduate Seminar I. 1 unit**

Term Typically Offered: F

Prerequisite: Graduate standing.

Preparation for graduate studies and engineering careers. Further development of oral and written communication skills. 1 seminar.

**CE 592. Graduate Seminar II. 1 unit**

Term Typically Offered: W

Prerequisite: CE 591 and graduate standing.

Current research activities and analysis/design philosophies in civil and environmental engineering practice. Development of oral and written presentation skills. 1 seminar.

**CE 593. Cooperative Education Experience. 2 units**

Term Typically Offered: TBD

CR/NC

Prerequisite: Graduate standing and consent of instructor.

Advanced study analysis and part-time work experience in student's career field; current innovations, practices, and problems in administration, supervision, and organization of business, industry, and government. Must have demonstrated ability to do independent work and research in career field. Credit/No Credit grading only.

**CE 594. Cooperative Education Experience. 6 units**

Term Typically Offered: TBD

CR/NC

Prerequisite: Graduate standing and consent of instructor.

Advanced study analysis and full-time work experience in student's career field; current innovations, practices, and problems in administration, supervision, and organization of business, industry, and government. Must have demonstrated ability to do independent work and research in career field. Credit/No Credit grading only.

**CE 595. Cooperative Education Experience. 12 units**

Term Typically Offered: TBD

CR/NC

Prerequisite: Graduate standing and consent of instructor.

Advanced study analysis and full-time work experience in student's career field; current innovations, practices, and problems in administration, supervision, and organization of business, industry, and government. Must have demonstrated ability to do independent work and research in career field. A fully-developed formal report and evaluation by work supervisor required. Credit/No Credit grading only.

**CE 596. Comprehensive Examination. 1 unit**

Term Typically Offered: F, W, SP

CR/NC

Prerequisite: Graduate standing. Recommended: Student should be in the final quarter of completing graduate coursework (45 units of 400 and 500 level coursework) and prepared to take the MS exam.

Comprehensive exam for a non-thesis master's student. The comprehensive examination assesses the student's ability to integrate knowledge, show critical and independent thinking, and demonstrate mastery of the subject matter. Timing of the comprehensive exam shall be scheduled with the faculty advisor per department guidelines.

**CE 599. Design Project (Thesis). 1-9 units**

Term Typically Offered: F, W, SP

Prerequisite: Graduate standing.

Each individual or group will be assigned a project for solution under faculty supervision as a requirement for the master's degree, culminating in a written report/thesis.