CIVIL ENGINEERING (CE)

Coursework in the College of Engineering may transfer differently between the quarter and semester systems. If a course includes a “Formerly” or “Replaced” label, please check the official course mapping (https://eadvise.calpoly.edu/semester-conversion-ceng-transition/) information available through Engineering Student Services to confirm how the credit will apply toward your degree requirements.

undefined

CE Courses

CE 1111 Introduction to Civil Engineering (1 unit)
Term Typically Offered: F
CR/NC

Review of civil engineering and associated technical disciplines. Case study analysis. Critical self-reflection and educational goals. Leadership, ethical decision-making, design and systems thinking, sustainability, collaboration, research, engineering communication, learning, and motivation. Engineering societies and professional registration. Credit/No Credit grading only. 1 lecture. Formerly CE 111.

CE 1112 Spatial Visualization and Drawing (3 units)
Term Typically Offered: F, SP
Corequisite: One of the following: CE 111, CE 1111, ENVE 111, or ENVE 1111.

Mentally manipulate two- and three-dimensional structures. Theory and practice of plane surveying. Application of Geographic Information Systems (GIS). Introduction to engineering drawing in the environmental, geotechnical, transportation, and structural sub-disciplines of civil engineering, including sketching and computer aided drawing (CAD). Course may be offered in classroom-based or online format. 1 lecture, 2 activities. Crosslisted as CE/ENVE 1112. Formerly CE 113.

CE 2200 Special Problems for Undergraduates (1-2 units)
Term Typically Offered: F, SP
CR/NC
Prerequisite: Consent of instructor and department chair.

Individual investigation, research, studies, or surveys of selected problems. Repeatable up to 4 units. Credit/No Credit grading only. Crosslisted as CE/ENVE 2200. Formerly CE 200.

CE 2251 Computational Applications in Civil and Environmental Engineering (2 units)
Term Typically Offered: F, SP
Prerequisite: MATH 143 or MATH 1262. Corequisite: CHEM 124 or CHEM 1120; and PHYS 143 or PHYS 1143.

Spreadsheet and programming-based approaches to civil and environmental engineering problems. Data analysis and management. Introductory linear regression, statistics and uncertainty. Financial analysis. Macros and user interfaces. Conditional and iterative analysis. Basic differential equations. Linear and basic nonlinear systems. Course may be offered in classroom-based or hybrid format. 2 activities. Crosslisted as CE/ENVE 2251. Formerly CE 251.

CE 2259 Civil Engineering Materials (3 units)
Term Typically Offered: F, SP
Prerequisite: CHEM 124 or CHEM 1120; and ENGR 2211 or CE 204 and ME 211.

Nature and behavior of materials used for structural, water resources, transportation, geotechnical, and environmental engineering. Experimental determination of mechanical and corrosion properties. Material selection considering mechanical, durability, and sustainability factors. Use of industry standard test equipment. 2 lectures, 1 laboratory. Formerly CE 259.

CE 2270 Special Topics (1-4 units)
Term Typically Offered: TBD
Prerequisite: Consent of instructor.

Directed group study of special topics. The Class Schedule will list topic selected. Repeatable up to 8 units. 1 to 4 lectures. Crosslisted as CE/ENVE 2270. Formerly CE 270.

CE 3321 Fundamentals of Transportation Engineering (4 units)
Term Typically Offered: F, SP
Prerequisite: One of the following: CE 259 or CE 2259, CM 113 or CM 1113, or ENVE 3465.

Characteristics and functions of different modes of transportation. Fundamentals of transportation design, operations, and planning. Evaluation of costs, benefits, and environmental considerations. Course may be offered in classroom-based or online format. 2 lectures, 2 activities. Formerly CE 321.

CE 3336 Environmental Fluid Mechanics and Hydraulic Systems (4 units)
Term Typically Offered: F, SP
Prerequisite: CE 204 and ME 211 or ENGR 2211; MATH 143 or MATH 1262; and PHYS 143 or PHYS 1143.

Theory and application of fluid statics and dynamics to air and water systems. Fluid properties, pressure within stationary and moving systems, momentum, pipe flow, water regulations and treatment. 3 lectures, 1 laboratory. Crosslisted as CE/ENVE 3336.

CE 3337 Water Resources & Environmental Engineering (4 units)
Term Typically Offered: F, SP
Prerequisite: CE/ENVE 3336; or CE 336 and ENVE 264 or ENVE 331.

Hydrology, hydraulics, and environmental aspects of surface and groundwater systems and their applications to water infrastructure. Systems thinking, climate change, and social and public health issues related to water resources and environmental engineering. Field trip required. 3 lectures, 1 laboratory. Crosslisted as CE/ENVE 3337. Formerly CE 337.

CE 3352 Structural Analysis (4 units)
Term Typically Offered: F, SP
Prerequisite: ENGR 2211 or CE 204 and ME 211.

Analysis of 2D and 3D stress and strain conditions in structural materials. Analysis of beam buckling failure. Deflections of determinate and indeterminate structures, including beams, trusses, and frames, using different analytical methods. 3 lectures, 1 laboratory. Formerly CE 352.

CE 3355 Reinforced Concrete Design (3 units)
Term Typically Offered: F, SP
Prerequisite: CE 259 or CE 2259; and CE 352 or CE 3352.

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. 2 lectures, 1 laboratory. Formerly CE 355.

CE 3375 Fundamentals of Construction Engineering and Management (4 units)
Term Typically Offered: F, SP
Prerequisite: One of the following: CE 259, CE 465, CE 2259, or CE/ENVE 3465.

Construction engineering fundamentals, project lifecycle, procurement methods, cost engineering, earthworks, and soil erosion. Construction loads, temporary structures, and shoring and bracing. Construction equipment, project scheduling, and construction safety. Course may be offered in classroom-based or online format. 3 lectures, 1 laboratory. Formerly CE/CM 371.

CE 3381 Geotechnical Engineering (4 units)
Term Typically Offered: F, SP
Prerequisite: CE/ENVE 3336 or ME 341 or ENVE 264; and ENGR 2211 or CE 204.

Engineering geology, weight-volume relationships, clay mineralogy, soil classification, compaction, geostatic stress distributions, steady-state flow, consolidation settlement/rate, shear strength, lateral earth pressure, retaining wall, bearing capacity, and slope stability analyses. Use of standardized laboratory tests to determine engineering properties of soils. 3 lectures, 1 laboratory. Formerly CE 381.

CE 3465 Infrastructure Systems (2 units)
Term Typically Offered: F
Prerequisite: Junior standing. Recommended: Three of the following: CE 321, CE 3321, CE/ENVE 3336, CE 336, CE/ENVE 3337, CE 352, CE 3352, CE 355, CE 3355, CE 381, CE 3381, ENVE 438, ENVE 3438, ENVE 450, or ENVE 3450.

Development of civil/environmental infrastructure as a multi-component system. Integration of civil/environmental engineering disciplines, as well as related non-engineering disciplines, as a project goes from concept through construction. Consideration of regulatory, social, management, economic, historical, and other non-technical factors. Field trip required. 2 activities. Crosslisted as CE/ENVE 3465. Formerly CE 465.

CE 4356 Structural Steel Design (4 units)
Term Typically Offered: F, SP
Prerequisite: CE 352 or CE 3352.

American Institute of Steel Construction Load and Resistance Factor Design (AISC-LRFD). Specifications for design of structural steel components in building systems, including tension members, columns, beams, beam-columns, basic welded connections, and basic bolted connections. 3 lectures, 1 laboratory. Formerly CE 356.

CE 4400 Special Problems (1-2 units)
Term Typically Offered: F, SP
Prerequisite: Consent of department chair.

Individual investigation, research, studies, or surveys of special problems. Repeatable up to 4 units. Formerly CE 400.

CE 4403 Civil Engineering Design Competition (1 unit)
Term Typically Offered: F, SP
Prerequisite: CE 113 or CE/ENVE 1112; CE 251 or CE 2251; and CE 259 or CE 2259.

Design, build, test, and present a solution to a civil engineering problem posed by a student design competition. The Class schedule will list subtitle selected. Repeatable up to 4 units. 1 laboratory. Formerly CE 403.

CE 4404 Applied Finite Element Analysis (3 units)
Term Typically Offered: F, SP
Prerequisite: One of the following: BMED 410, BMED 3410, CE 352, CE 3352, ME 328, or ME 3328.

Finite element solutions to engineering elastostatic problems using commercial finite element code. Practical modeling assignments. 2 lectures, 1 laboratory. Crosslisted as BMED/CE/ME 4404. Formerly BMED/CE/ME 404.

CE 4407 Structural Dynamics (4 units)
Term Typically Offered: TBD
Prerequisite: CE 352 or CE 3352; and one of the following: ME 212, ME 2212, or ENGR 2212.

Dynamics of structural systems. Creation of models for stiffness, mass, and damping. Numerical methods and programming techniques for predicting dynamic behavior. Comparison of models with experimental testing. Analysis of multidimensional structural systems via modal analysis and direct time integration. 3 lectures, 1 laboratory. Formerly CE 407.

CE 4413 Advanced Civil Computer-Aided Site Design (2 units)
Term Typically Offered: F
Prerequisite: One of the following: CM 239, CM 2239, CE 113, or CE/ENVE 1112; and one of the following: CE 321, CE 465, CE 3321, or CE/ENVE 3465.

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. Formerly CE 413.

CE 4415 Advanced Building Information Modeling for Civil Engineering (4 units)
Term Typically Offered: F
Prerequisite: CE 3375 or CE/CM 371.

Building Information Modeling (BIM) process to design, optimize, construct, and manage vertical structures. BIM based quantity take-off, clash detection, 4D modeling, facility management, and 3D laser scanner applications. Course may be offered in classroom-based or online format. 2 lectures, 2 laboratories. Formerly CE 415.

CE 4421 Traffic Engineering (3 units)
Term Typically Offered: F
Prerequisite: Graduate standing, CE 321, or CE 3321.

Principles of traffic circulation on highway systems and other modes. Traffic control. Traffic data collection and analysis. Capacity analysis. Traffic modeling. New technologies for traffic flow monitoring and management. Field trip may be required. Course may be offered in classroom-based or online format. 2 lectures, 1 laboratory. Formerly CE 421.

CE 4422 Highway Geometrics and Design (3 units)
Term Typically Offered: TBD
Prerequisite: CE 321 or CE 3321.

Principles of geometric design as they relate to highway facilities. Roadway design safety standards. Horizontal, vertical, and cross section components for roadway segments. Interchange and ramp design. Design for safety. Traffic calming methods. Cost/benefit analysis and environmental impacts. Course may be offered in classroom-based or online format. 2 lectures, 1 laboratory. Formerly CE 422.

CE 4423 Intelligent Transportation Systems (3 units)
Term Typically Offered: SP
Prerequisite: CE 321, CE 3321, 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 including the National Architecture for ITS. Field trip may be required. Course may be offered in classroom-based or online format. 2 lectures, 1 laboratory. Formerly CE 423.

CE 4424 Public Transportation (3 units)
Term Typically Offered: TBD
Prerequisite: CE 321 or CE 3321.

Development, operation, management, financing, evaluation, and travel demand estimation for urban public transportation systems. Legislative, political, social, and economic aspects of public transportation systems. Methodology and procedures for transit planning. Review of transit studies. 2 lectures, 1 laboratory. Formerly CE 424.

CE 4425 Introduction to Railway Engineering (3 units)
Term Typically Offered: SP
Prerequisite: CE 321 or CE 3321.

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. Field trip may be required. Course may be offered in classroom-based or online format. 3 lectures. Formerly CE 425.

CE 4429 Highway Pavement Design (3 units)
Term Typically Offered: F, SP
Prerequisite: CE 259 or CE 2259, and CE 381 or CE 3381; or CM 113 or CM 1113, and CM 213 or CM 2113.

Theories, principles, and procedures in the structural design of highway pavements. Performance of flexible and rigid pavements in the field. characterization of pavement materials. Design of flexible and rigid pavements. Analysis software. Laboratory testing of pavement materials. Field trip may be required. Course may be offered in classroom-based or online format. 2 lectures, 1 laboratory. Formerly CE 429.

CE 4431 Introduction to Coastal Engineering (4 units)
Term Typically Offered: TBD
Prerequisite: CE 336 or CE/ENVE 3337; MATH 244 or MATH 2341; and PHYS 143 or PHYS 1143.

Introduction to Coastal Engineering, including theory and analysis of waves and tides. Wave generation, propagation, and dispersion. Wave velocities, forces, pressures, run-up and overtopping. Beach processes. Coastal protection structures. Estuary processes. Tides and tidal theory. Coastal design considerations. Sea-level rise. Field trip required. 4 lectures. Formerly CE 431.

CE 4432 Coastal Engineering II (4 units)
Term Typically Offered: SP
Prerequisite: CE 431 or CE 4431; and STAT 312 or STAT 3210.

Coastal processes that influence coastal infrastructure design. Sea-level rise, subsidence, tides, storm surge, tsunamis, wind and wave setup. Introduction to tidal currents, wind circulation, estuarine circulation and salinity intrusion, erosion and sediment transport, turbulent mixing, dispersion, energy dissipation. Harbor resonance. Field trip required. 4 lectures. Formerly CE 432.

CE 4433 Open Channel Hydraulics (4 units)
Term Typically Offered: F
Prerequisite: CE 336 or CE/ENVE 3337.

Analysis and characteristics of flow in open channels. Critical, uniform, gradually and rapidly varied flows. Channel design, transitions and controls. Hydraulic jump and energy dissipaters. Unsteady flows, waves and wave propagation, flood routing. Software applications and numerical methods. 3 lectures, 1 laboratory. Formerly CE 433.

CE 4434 Groundwater Hydraulics and Hydrology (3 units)
Term Typically Offered: SP
Prerequisite: Graduate standing, CE 336, or CE/ENVE 3337.

Fundamental equations of groundwater flow, Darcy's Law, differential equations for confined and unconfined flows. Leaky aquifers. Aquifer response to recharge, pumping and injection. Groundwater modeling. Saltwater intrusion and groundwater contamination. Sustainable groundwater management. 3 lectures. Formerly CE 434.

CE 4435 Engineering Hydrology and Stormwater Management (4 units)
Term Typically Offered: F
Prerequisite: Graduate standing, CE 336, or CE/ENVE 3337.

Determining runoff peak, volume, and hydrograph for a storm event. Stormwater drainage systems for land development projects, post-construction stormwater requirements and solutions, floodplain analysis, climate/landuse change impacts on runoff and drainage infrastructure. 3 lectures, 1 activity. Formerly CE 435.

CE 4436 Heavy Civil Temporary Structures and Shoring (3 units)
Term Typically Offered: F
Prerequisite: One of the following: ARCE 211, ARCE 1121, CE 352 or CE 3352; and one of the following: CM 314, CM 3314, CE/CM 371, or CE 3375.

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, 1 laboratory. Crosslisted as CE/CM 4436. Formerly CE/CM 436.

CE 4437 Heavy Civil Projects and Equipment (3 units)
Term Typically Offered: SP
Prerequisite: One of the following: CM 314, CM 3314, CE/CM 371, or CE 3375.

Heavy civil projects logistics, construction, operations, planning, management, workflow and sequencing, equipment management, fleet configuration and maintenance, equipment productivity and cost optimization, asphalt specifications. 2 lectures, 1 laboratory. Crosslisted as CE/CM 4437. Formerly CE/CM 437.

CE 4440 Hydraulic Systems Engineering (4 units)
Term Typically Offered: F
Prerequisite: Graduate standing, CE 336, or CE 3336.

Water and storm water flows. Design of water distribution systems. Multiple pumps and pump systems. Water sources for municipal water supply, fire flows and storage reservoirs. Storm water management. Design of storm sewers, inlets, gutters and culverts. Best Management Practices (BMPs) and Low Impact Developments (LIDs). 3 lectures, 1 laboratory. Formerly CE 440.

CE 4446 Seismic Principles for Civil Engineering (1 unit)
Term Typically Offered: SP
Prerequisite: CE 355 or CE 3355.

American Society of Civil Engineers (ASCE) Standard 7 seismic load provisions for buildings and other civil structures. Relevant preparation for the California Civil Seismic Principles Examination. 1 activity.

CE 4451 Applied Numerical Methods in Engineering (4 units)
Term Typically Offered: F, SP
Prerequisite: CE 251 or CE/ENVE 2251.

Scalars, vectors, and matrices in finite precision. Solution of linear and nonlinear equations. Eigensystem calculations and applications. Data representation, visualization, and processing. Interpolation and model fitting. Numerical integration and differentiation. Numerical methods for ordinary and partial differential equations. 3 lectures, 1 laboratory.

CE 4455 Design of Timber Structures (4 units)
Term Typically Offered: F
Prerequisite: CE 355 or CE 3355.

Analysis and design of timber structures, emphasizing construction methodology and material behavior. Physical and mechanical properties of structural lumber and glued laminated timber. Lateral load paths, diaphragms, connections, shear wall design, combined load design. Construction sequencing for timber structures. 3 lectures, 1 laboratory. Formerly CE 455.

CE 4457 Bridge Engineering (4 units)
Term Typically Offered: SP
Prerequisite: CE 355 or CE 3355; and CE 356 or CE 4356.

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. Course may be offered in classroom-based or online format. 3 lectures, 1 laboratory. Formerly CE 457.

CE 4459 FRP Strengthening of Reinforced Concrete Structures (4 units)
Term Typically Offered: TBD
Prerequisite: CE 355 or CE 3355.

Flexural and shear strengthening of reinforced concrete members using fiber-reinforced plastic (FRP) composite. Seismic upgrade and rehabilitation of columns. Design philosophy and methodology based on the current understanding of FRP strengthening techniques. Course may be offered in classroom-based or online format. 3 lectures, 1 activity. Formerly CE 459.

CE 4466 Senior Design Project I (1 unit)
Term Typically Offered: TBD
Prerequisite: Senior standing; CE 465 or CE/ENVE 3465; and consent of instructor. Corequisite: CE 321 or CE 3321; CE 336 or CE/ENVE 3337; CE 355 or CE 3355; CE/CM 371 or CE 3375; and CE 381 or CE 3381.

Work in multi-disciplinary teams to complete an integrated civil design project. Includes project-focused instruction on selected topics in construction, geotechnical, structural, transportation, and water resources engineering design. Reinforcement of team building, technical communications, and professional practice skills. 1 activity. Formerly CE 466.

CE 4467 Senior Design Project II (3 units)
Term Typically Offered: SP
Prerequisite: CE 466 or CE 4466.

Continuation of work on multi-disciplinary teams to complete an integrated civil design project. Formal instruction on selected topics in construction, geotechnical, structural, transportation, and water resources engineering design culminating with oral and written presentations. 2 lectures, 1 laboratory. Formerly CE 467.

CE 4470 Special Advanced Topics (1-4 units)
Term Typically Offered: TBD
Prerequisite: Consent of instructor.

Directed group study of special topics for advanced students. The Class Schedule will list topic selected. Repeatable up to 8 units. 1 to 4 lectures. Formerly CE 470.

CE 4471 Special Advanced Laboratory (1-4 units)
Term Typically Offered: TBD
Prerequisite: Consent of instructor.

Directed group laboratory study of special topics for advanced students. The Class Schedule will list topic selected. Repeatable up to 8 units. 1 to 4 laboratories. Formerly CE 471.

CE 4474 Environmental Compliance and Permitting (2 units)
Term Typically Offered: TBD
Prerequisite: Senior standing; and one of the following: CE 336, CE/ENVE 3337, CE 465, CE/ENVE 3465, CM 314, or CM 3314.

Fundamentals of State and Federal environmental review processes and regulations essential to permitting Civil Engineering projects. Permit compliance through post-construction. Consideration of broader impacts including climate change and environmental justice. Course may be offered in classroom-based or hybrid format. 1 lecture, 1 activity. Formerly CE 474.

CE 4475 Mechanical, Electrical, and Energy Systems in Buildings (3 units)
Term Typically Offered: F
Prerequisite: CE 336 or CE/ENVE 3336.

Mechanical and electrical systems that operate in the background of modern buildings, with a focus on energy performance. 2 lectures, 1 laboratory. Formerly ARCE/CE 475.

CE 4481 Foundation Design and Construction (4 units)
Term Typically Offered: F, SP
Prerequisite: CE 381 and CE 382; or CE 3381.

Analysis and design of shallow and deep foundation systems for vertical, lateral, and combined loading. Bearing capacity, settlement, and earth pressure. Foundation type selection. Construction methods, field monitoring, and load-testing. Structural design considerations. Computer-aided analysis. 4 lectures.

CE 4482 Earth Fills and Embankments (3 units)
Term Typically Offered: SP
Prerequisite: CE 381 and CE 382; or CE 3381.

Design and construction of structural fill, embankments, abutments, earth dams, and levees. Design and performance of compacted fill. Slope stability and settlement. Seepage analysis. Filter design and criteria. Computer-aided analysis. 3 lectures.

CE 4483 Geotechnical Testing and Modeling (2 units)
Term Typically Offered: SP
Prerequisite: CE 381 and CE 382; or CE 3381.

Advanced soils testing and modeling for saturated flow, volume change, and shear strength. Cyclic loading of soils. Experiment design. Numerical methods and computational tools for geotechnical analysis, design, and visualization. 1 lecture, 1 laboratory.

CE 4484 Earth Retention, Excavations, and Tunnels (3 units)
Term Typically Offered: SP
Prerequisite: CE 381 and CE 382; or CE 3381.

Earth pressure theory and lateral earth pressure calculations. Analysis, design, and construction of earth retention systems, ground anchors, mechanically-stabilized earth, excavations, and soft ground tunnels. Dewatering methods and soil improvement. Computer-aided analysis. 3 lectures.

CE 4486 Introduction to Geological Engineering (4 units)
Term Typically Offered: TBD
Prerequisite: CE 381 and CE 382, or CE 3381; and GEOL 201 or GEOL 2240.

Evaluation of the engineering properties of rocks. Consideration of geomorphic mechanisms as they pertain to civil infrastructure and the built environment. Civil engineering analysis and design related to rock foundations, rock slopes, rock tunneling, rockfall hazard, coastal bluffs. Field trip may be required. 4 lectures. Formerly CE 486.

CE 4495 Cooperative Education Experience (1-12 units)
Term Typically Offered: TBD
CR/NC
Prerequisite: Consent of instructor.

Work experience in business, industry, government, and other areas of student career interest related to civil engineering. Paid position; typically requires relocation for at least one semester. Registration in course, a formal scope of work, and evaluation by supervisor required. Credit/No Credit grading only. Repeatable up to 24 units. Crosslisted as CE/ENVE 4495. Formerly CE 495.

CE 5488 Engineering Risk Analysis (4 units)
Term Typically Offered: TBD
Prerequisite: STAT 312, STAT 3210, 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. Crosslisted as ARCE/CE 5488. Formerly CE 488.

CE 5500 Individual Study (1-2 units)
Term Typically Offered: F, SP
Prerequisite: Graduate standing and consent of department chair.

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. Repeatable up to 4 units. Crosslisted as CE/ENVE 5500. Formerly ENVE 500.

CE 5502 Finite Element Analysis of Structures (4 units)
Term Typically Offered: F
Prerequisite: CE 407 or CE 4407, and CE 4451; or Graduate standing.

Stiffness and flexibility procedures for the analysis of one, two, and three-dimensional line elements under both static and dynamics loading conditions. Development of algorithms and programs for use in the analysis of structural frameworks. Discussion of modeling issues and limitations. 3 lectures, 1 laboratory. Formerly CE 501.

CE 5504 Finite Element Analysis of Continua (4 units)
Term Typically Offered: SP
Prerequisite: One of the following: BMED/CE/ME 404, BMED/CE/ME 4404, CE 501, CE 5502, AERO 431, or AERO 4431.

Finite element theory and application with a focus on numerical implementation. Strong and weak forms, variational theorems, displacement based methods, mixed methods, viscoelasticity and plasticity type formulations, augmented Lagrangian formulations, transient and modal analysis, and finite deformation. 3 lectures, 1 laboratory. Crosslisted as AERO/BMED/CE/ME 5504. Formerly CE/ME 504.

CE 5511 Continuum Mechanics and Elasticity (3 units)
Term Typically Offered: F
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 may be offered in classroom-based or hybrid format. 3 lectures. Crosslisted as CE 5511/ME 5501. Formerly CE 511/ME 501.

CE 5513 Inelastic Stress Analysis (3 units)
Term Typically Offered: SP
Prerequisite: One of the following: CE 511, CE 5511, ME 501, or ME 5501.

Perfectly plastic and work hardening materials. Von Mises and Tresca yield, isotropic and kinematic hardening flow rules, and boundary-value problems. Finite elasticity, including kinematics, Cauchy- and Green-elasticity, invariance, constraints, Neo-Hookean and Mooney-Rivlin materials, experimental approaches, anisotropic and fiber reinforced materials, boundary-value problems, stability and strain energy convexity, and viscoelasticity. Course may be offered in classroom-based or hybrid format. 3 lectures. Crosslisted as CE 5513/ME 5503. Formerly CE 513/ME 503.

CE 5523 Transportation Systems Planning (4 units)
Term Typically Offered: F
Prerequisite: CE 321, CE 3321, or graduate standing.

Planning of 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 activities. Formerly CE 523.

CE 5525 Airport Planning and Design (3 units)
Term Typically Offered: TBD
Prerequisite: CE 321, CE 3321, or graduate standing.

Historical background of aviation and airport development. Financing and 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. Field trip required. Course may be offered in classroom-based or online format. 2 lectures, 1 laboratory. Formerly CE 525.

CE 5526 Transportation Safety (4 units)
Term Typically Offered: TBD
Prerequisite: CE 321 or CE 3321, and STAT 312 or STAT 3210; or graduate standing.

Nature and extent of transportation safety problems worldwide and in the US. Road safety, human factors, vehicle safety; crash data collection and management; safety planning and audits; safe systems approach; transportation crash studies; predictive model building; "before-after" studies; countermeasure design. Field trip required. Course may be offered in classroom-based or online format. 3 lectures, 1 laboratory. Formerly CE 526.

CE 5527 Sustainable Mobility (3 units)
Term Typically Offered: SP
Prerequisite: One of the following: CE 321 or CE 3321, CRP 435 or CRP 4435, or graduate standing.

Analysis and design for sustainable mobility from an interdisciplinary perspective, including pedestrians, bicyclists, electrification, technologies, and transit. Addresses economy, climate change, environment, and equity issues. 2 lectures, 1 laboratory. Formerly CE 527.

CE 5528 Transportation Economics and Analysis (3 units)
Term Typically Offered: TBD
Prerequisite: CE 321, CE 3321, 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. Course may be offered in classroom-based or online format. 2 lectures, 1 laboratory. Formerly CE 528.

CE 5529 Modeling and Simulation in Transportation (4 units)
Term Typically Offered: SP
Prerequisite: CE 321, CE 3321, 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. Course may be offered in classroom-based or online format. 2 lectures, 2 activities. Formerly CE 529.

CE 5533 Sustainable Urban Stormwater Management (4 units)
Term Typically Offered: SP
Prerequisite: CE 336, CE/ENVE 3337, or graduate standing.

Green stormwater infrastructure including low impact developments, green streets, and regional multi-benefit projects. Hydromodification, erosion and sedimentation. Evaluating benefits of green infrastructure for water quality, flood control, and drought management. 3 lectures, 1 activity. Formerly CE 533.

CE 5536 Advanced Modeling in Water Resources (4 units)
Term Typically Offered: TBD
Prerequisite: CE 433 or CE 4433, and CE 435 or CE 4435; or graduate standing.

Modeling and analysis of water resources systems. Applications of computer models, Geographic Information Systems, remote sensing, and data analytics to the planning and management of water infrastructure. Broader considerations of water resources systems including climate change impacts and social justice. 3 lectures, 1 laboratory. Formerly CE 536.

CE 5537 Groundwater Contamination (4 units)
Term Typically Offered: F
Prerequisite: CE 434, CE 4434, or graduate standing.

Sources and types of groundwater contamination. Contaminant fate and transport mechanisms. Prediction of contaminant transport and transformation in groundwater using analytical and numerical models. Design of engineered containment and remediation systems to mitigate groundwater pollution. Environmental justice considerations. 3 lectures, 1 activity. Formerly CE 537.

CE 5538 Urban Water Systems (4 units)
Term Typically Offered: SP
Prerequisite: CE 440 or CE 4440.

Urban Hydrology; Relationships between surface and groundwater elements of water sources and disposal. Urban Hydraulics; Integration of water delivery, wastewater collection, drainage systems, and associated treatment components in urbanizing areas. Best management practices (BMPs) and low impact developments (LIDs); Sustainable infrastructure. 3 lectures, 1 laboratory. Formerly CE 538.

CE 5539 Environmental Hydraulics (4 units)
Term Typically Offered: TBD
Prerequisite: CE 336, CE/ENVE 3337, 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. Formerly CE 539.

CE 5541 Extreme Events and Climate Change in Water Resources (4 units)
Term Typically Offered: SP
Prerequisite: CE 251 or CE/ENVE 2251 and STAT 312 or STAT 3210; or graduate standing.

Physics and statistics behind risk and hazard assessment in water resources. Exceedance probabilities; hazard assessments; return periods; intensity-duration-frequency curves. Effects of climate change, including land use and hydrology changes, sea-level rise and subsidence, altered rainfall intensity. Coastal and inland hazards. 4 lectures.

CE 5553 Ductile Design of Steel Structures (4 units)
Term Typically Offered: SP
Prerequisite: CE 356, CE 4356, or graduate standing.

American National Standards Institute/ American Institute of Steel Construction (ANSI/AISC) 341 seismic provisions for typical lateral force resisting systems in structural steel buildings, including moment frames, concentrically braced frames, and eccentrically braced frames. 3 lectures, 1 laboratory. Formerly CE 553.

CE 5556 Fiber Reinforced Polymer (FRP) Composites in Structural Engineering (4 units)
Term Typically Offered: TBD
Prerequisite: CE 355, CE 3355, or graduate standing.

Strengthening/rehabilitation of reinforced concrete (RC) members using Fiber-Reinforced Plastic (FRP) composite. Seismic upgrade and rehabilitation of columns. Design of new RC structures with FRP rebars. Based on current research and applications. Not open to students with credit in CE 459 or CE 4459. Course may be offered in classroom-based or online format. 3 lectures, 1 laboratory. Formerly CE 556.

CE 5557 Seismic Analysis and Design (4 units)
Term Typically Offered: SP
Prerequisite: CE 407, CE 4407, or graduate standing.

General procedures of seismic analysis and design of civil structures. Underlying principles of seismic hazards analysis, structural dynamics, and inelastic structural behavior. Integration of course topics into building codes. 3 lectures, 1 laboratory. Formerly CE 557.

CE 5558 Structural Health Monitoring (4 units)
Term Typically Offered: F
Prerequisite: CE 407, CE 4407, or graduate standing.

Introduction of structural health monitoring for assessing conditions of various critical structures. Introduction of sensor instrumentation, working mechanism, and performance characteristics. Analysis of sensor signals to extract features of structural performance. 3 lectures, 1 laboratory.

CE 5559 Prestressed Concrete Design (4 units)
Term Typically Offered: SP
Prerequisite: CE 355, CE 3355, or graduate standing.

Principals of behavior, analysis, and design of prestressed concrete elements and structures. Determinate precast pre-tensioned concrete components for buildings and highway construction. Indeterminate post-tensioned concrete building structures. Prestressing losses. 4 lectures. Formerly CE 559.

CE 5570 Special Advanced Topics (1-4 units)
Term Typically Offered: TBD
Prerequisite: Graduate standing and consent of instructor.

Directed group study of special topics for advanced students. The Class Schedule will list topic selected. Repeatable up to 8 units. 1 to 4 seminars. Crosslisted as CE/ENVE 5570. Formerly CE 570.

CE 5571 Special Advanced Laboratory (1-4 units)
Term Typically Offered: TBD
Prerequisite: Graduate standing and consent of instructor.

Directed group laboratory study of special topics for advanced students. The Class Schedule will list topic selected. Repeatable up to 8 units. 1 to 4 laboratories. Crosslisted as CE/ENVE 5571. Formerly CE 571.

CE 5575 Engineering Project Management (4 units)
Term Typically Offered: TBD
Prerequisite: Senior or graduate standing.

Principles and techniques of managing projects from conceptual phase through project definition, design, construction, and closeout. Project management with aspects of scope definition, estimates and budgeting, monitoring and control, design coordination, construction phases, risks, quality, procurement, and leadership. Course may be offered in classroom-based or online format. 3 lectures, 1 laboratory. Formerly CE 572.

CE 5581 Advanced Geotechnical Engineering (4 units)
Term Typically Offered: SP
Prerequisite: CE 381 and CE 382, or CE 3381; or graduate standing.

Advanced field and laboratory tests for shear strength and volume change. Collection and interpretation of test data for analysis and design. Site characterization through geotechnical testing. Geotechnical engineering report preparation. 3 lectures, 1 laboratory. Formerly CE 581.

CE 5583 Geotechnical Earthquake Engineering (4 units)
Term Typically Offered: SP
Prerequisite: CE 4481 or graduate standing.

Ground motion topics; tectonics, seismology, seismic hazard analysis, dynamic behavior of soils, seismic site response, and soil structure interaction. Ground failure topics; surface fault rupture, soil liquefaction, lateral spreading, cyclic failure, seismic compression, and seismic slope stability. 4 lectures. Formerly CE 583.

CE 5584 Landslides and Slope Stabilization (3 units)
Term Typically Offered: SP
Prerequisite: CE 381, CE 3381, or graduate standing.

Geotechnical and geological investigations for landslides and slope instability. Computer-aided slope stability analysis methods. Back-analysis of existing landslides. Field instrumentation. Methods for slope stabilization and reconstruction. Influence of groundwater and earthquakes. Field trip required. 3 lectures.

CE 5587 Geoenvironmental Engineering (3 units)
Term Typically Offered: SP
Prerequisite: CE 381, CE 3381, or graduate standing.

Principles for containment applications. Engineering properties of soils and geosynthetics and their interaction with contaminants and wastes. Liners. Covers. Leachate and gas collection systems. Contaminant transport. Monitoring systems. Beneficial reuse of wastes and byproducts. 3 lectures. Formerly CE 587.

CE 5588 Ground Improvement (4 units)
Term Typically Offered: TBD
Prerequisite: CE 381, CE 3381, or graduate standing.

Ground improvement applications for modification of geomechanical and hydraulic properties of soils. Engineering properties of soft and problematic ground. Mechanical, chemical, and thermal stabilization for geotechnical applications. Soil reinforcement, geosynthetics, soil inclusions, grouting, drainage, containment, slurry walls, blasting, sustainability. 4 lectures. Formerly CE 588.

CE 5589 Geosynthetics Engineering (4 units)
Term Typically Offered: TBD
Prerequisite: CE 381, CE 3381, or graduate standing.

Geosynthetics applications within civil engineering. Design content for geotechnical, geoenvironmental, and transportation applications. Manufacturing processes, material properties, interaction with soils, construction, and service conditions. Separation, reinforcement, drainage, filtration, and barrier applications. 4 lectures. Formerly CE 589.

CE 5591 Graduate Seminar I (1 unit)
Term Typically Offered: F
Prerequisite: Graduate standing.

Preparation for conducting independent research or graduate-level independent projects in the field of civil and environmental engineering. Development of graduate-level written and oral communication skills. Research skills. Professional ethics. Career pathways. 1 seminar. Crosslisted as CE/ENVE 5591. Formerly CE 591.

CE 5592 Graduate Seminar II (1 unit)
Term Typically Offered: TBD
Prerequisite: CE 591 or CE/ENVE 5591. Corequisite: One of the following: CE 596, CE/ENVE 5597, CE/ENVE 599, or CE/ENVE 5599.

Preparation for advanced graduate studies and post-graduate engineering careers. Development of oral and written communication skills to a professional level. Presentation of research and/or project work to peers. 1 seminar. Crosslisted as CE/ENVE 5592. Formerly CE 592.

CE 5595 Cooperative Education Experience (1-8 units)
Term Typically Offered: TBD
CR/NC
Prerequisite: Graduate standing and consent of instructor.

Work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation for at least one term. Registration in course and a formal scope of work and evaluation by work supervisor required. Credit/No Credit grading only. Crosslisted as CE/ENVE 5595. Formerly CE 595.

CE 5597 Comprehensive Examination (1 unit)
Term Typically Offered: F, SP
CR/NC
Prerequisite: Graduate standing; and CE 591 or CE/ENVE 5591.

Comprehensive exam for a non-thesis master's student in civil engineering showing integration of technical knowledge, critical and independent thinking, and mastery of the subject matter. Scheduled with the faculty advisor, typically in the final semester of the graduate program. Credit/No Credit grading only. Formerly CE 596.

CE 5599 Thesis (1-6 units)
Term Typically Offered: F, SP
Corequisite: Graduate standing; and CE 591 or CE/ENVE 5591.

Under direction of an advisor, student conducts graduate-level research relevant to their field of study. Research efforts culminate in a written report/thesis and oral defense of the study. Repeatable up to 6 units. Formerly CE 599.