Civil Engineering (CE)

Courses

CE 101. Introduction to Civil Engineering. 1 Credit.
Course will be a series of lectures, discussions and group projects, concerning the practice of civil engineering and sustainable design. Topics include scope of civil engineering practice, professional ethics, professional practice issues, sustainable engineering design concepts, communication skills, project management and team-working, literature searches and information gathering, and career planning. Exposure to Grand Challenges. Prerequisite: CE major or department permission. S/U grading. F.

CE 102. Professional Assessment and Evaluation. 1 Credit.
This course is designed for students with industrial experience. Students complete a portfolio documenting educational and work experiences for evaluation, and individualized curriculum plans are developed. Based on the assessment and evaluation, some civil engineering requirements may be waived. Prerequisite: Work experience and/or technical school training plus completion of CHEM 121, CHEM 121L, PHYS 251, and MATH 265. S/U grading. F,S,SS.

CE 103. Graphical Communication. 3 Credits.
Development of visualization, technical communication, and documentation skills. The course covers 3D AutoCAD geometric modeling using current methods and techniques commonly found in the industry, Civil 3D land systems design program, and MicroStation. Fundamentals of land surface modeling and current surveying techniques will be taught in a combined lecture-laboratory format. On-campus students have access to necessary software programs through the CEM computer system. DEDP students are required to download a free computer-aided design software version from AUTODESK to their personal computers. Prerequisite: CE major or permission of department. S.

CE 306. Fluid Mechanics. 3 Credits.
Fluid properties; fluid statics and dynamics; transport theory and transport analogies, conservation of mass, energy, and momentum; dimensional analysis; boundary layer concepts; pipe flows; compressible flow; open channel flow. Prerequisite: PHYS 251 and MATH 265. F,S.

CE 313. General Surveying. 2 Credits.
Measurements of distances and angles, EDM, satellite and inertial systems, triangulation, differential leveling, horizontal curves, vertical curves, traverse surveys, U.S. public land surveys, earthwork, boundary surveys and construction surveys. Basic knowledge of geometry and trigonometry is required. Prerequisite: MATH 165 or permission of the instructor. Corequisite: On campus students must take CE 313L along with this class. F.

CE 313C. General Surveying. 2 Credits.
Measurements of distances and angles; EDM; satellite and inertial systems; triangulation; differential leveling; horizontal curves; vertical curves; traverse surveys; U.S. public land surveys; earthwork; boundary surveys; construction surveys. F.

CE 313L. General Surveying Laboratory. 1 Credit.
Course will involve laboratory assignments dealing with measurements of distances and angles; use of EDM, GPS, and automatic levels; traversing; leveling; horizontal curves; vertical curves; and topographic survey. Offered in Summer for DEDP students. Prerequisite: DEDP students must have completed CE 313. Corequisite: On-campus students must be enrolled in CE 313. F.

CE 351. Structural Mechanics. 4 Credits.
This course focuses on the analysis of structures. Topics covered include reactions, shear and bending moments, plane and space trusses, influence lines, deflections, virtual work, energy methods, approximate analysis, consistent deformation methods, slope-deflection and moment-distribution methods, an introduction to matrix methods, and the use of computer software for structural analysis. Prerequisite: ENGR 203. F.

CE 397. Cooperative Education. 1-2 Credits.
A practical work experience with an employer closely associated with the student's academic area. Arranged by mutual agreement among student, department and employer. The main benefit of coop credit is that it represents experience documented on your transcript. Coop credit represents an assurance that work performed on the job was a developmental experience for the student engineer. Prerequisite: Admission to the civil engineering program and consent of advisor. Repeatable to 24.00 credits. F,S,SS.

CE 401. Mechanics of Materials II. 3 Credits.
This course covers stress and strain theories in two and three dimensions, including transforming stresses and strains. Topics include tensor notation, linear and nonlinear stress-strain behavior, thermal stresses, and material behavior in isotropic, orthotropic, and anisotropic materials. The course also addresses yield criteria and failure theories under combined stresses, energy methods, torsion of noncircular and thin-walled sections, unsymmetrical bending, the shear center, and curved beams. CE 501 cannot be taken after completing CE 401. Prerequisite: ENGR 203. S, odd years.

CE 402. Structural Stability. 3 Credits.
This course covers the concept of stability and the application of equilibrium and energy methods in structural analysis. Topics include the stability of columns, beam-columns, frames, and inelastic buckling. It also explores stability analysis using slope-deflection and matrix methods and the use of codes for the stability design of aluminum and steel columns and frames. Additional topics include torsional and lateral-torsional buckling of beams and beam-columns. CE 502 cannot be taken after completing CE 402. Prerequisite: ENGR 203. On demand.

CE 403. Structural Dynamics. 3 Credits.
Introduction to vibration and dynamics, single degree freedom free vibration, single degree freedom forced vibration, harmonic and periodic excitations; pulse, introduction to viscous and non-viscous damping system, dynamic system identification, numerical methods to determine dynamic response; determination of earthquake response of linear elastic buildings; dynamics of generalized single degree of freedom systems, dynamics of shear buildings, dynamics of multi-degree of freedom systems, modal superposition, modal spectral analysis, structural dynamics in US building code. CE 503 cannot be taken after completing CE 403. Prerequisite: ENGR 202 and ENGR 203. On demand.

CE 409. Traffic Engineering: Operations. 3 Credits.
The course is designed to provide information on basic characteristics of traffic, including drivers, vehicles, volumes, speeds, delay, origins and destinations, traffic control devices, intersection performance, capacity, techniques for making traffic engineering investigations, techniques of conducting traffic studies, traffic laws and ordinances, regulations, design and application of signal systems, curb parking control, and CAV technologies impact on road capacities and mobility. Prerequisite or Corequisite: CE 416 or instructor consent. S.

CE 411. Civil Engineering Materials Laboratory. 1 Credit.
The course involves lab experiences designing experiments and determining the properties of coarse and fine aggregates, concrete, asphalt, steel, and wood. Students perform lab work in teams and write reports as a group and/or individually. Prerequisite: CE major and ENGL 130. Prerequisite or Corequisite: MATH 321 or CHE 315 or ECON 210, and CE 412L. F,SS.

CE 412. Soil Mechanics. 3 Credits.
To introduce students to the principles of soil mechanics, including weight-volume relationships, classification, compaction, effective stress, permeability and seepage, consolidation, shear strength, site exploration, introduction to lateral earth pressure, and slope stability. Prerequisite: ENGR 203. F.

CE 412L. Soil Mechanics Lab. 1 Credit.
The course involves lab experiences designing experiments and determining soil properties, including moisture content, specific gravity, grain size distribution, index properties, moisture-density relationships, permeability, and strength. Students perform lab work in teams and write reports as a group and/or individually. Prerequisite: CE major and ENGL 130. Corequisite: MATH 321 or CHE 315 or ECON 210; and CE 411 and CE 412. F,SS.

CE 413. Traffic Safety. 3 Credits.
This course introduces students to fundamental concepts in traffic safety analysis, equipping them with the skills to assess and improve safety in transportation systems. Students will write a research paper on a topic related to traffic safety and develop the ability to analyze crash data using different methodologies. Prerequisite or Corequisite: CE 416 or instructor consent. F.

CE 414. Foundation Engineering. 3 Credits.
Soil improvements and ground modifications, soil exploration and sampling, bearing capacity, spread footings, mat foundations, settlement analysis, drilled shaft and pile foundations, foundations on difficult soil. Prerequisite: CE 412. S.

CE 415. Asphalt Mix Design and Construction. 3 Credits.
This course focuses on the characterization of asphalt materials and mixtures, hot mix asphalt design, analysis, construction concepts, and the Superpave mix design method. It will also discuss balanced mix design, pavement distress mechanisms and performance testing, and recent developments in asphalt technology. Prerequisite: CE 412. S.

CE 416. Transportation Engineering. 3 Credits.
Introduction to highway engineering, traffic analysis, and transportation systems; road vehicle performance; highway, vehicle, and driver characteristics; highway capacity and level of service analysis; level of service analysis for signalized intersections; principles of traffic flow; geometric design of highways; pavement design and drainage; highway safety and transportation planning; and group design project. Prerequisite: CE 313. S.

CE 417. Transportation Asset Management. 3 Credits.
Course focused on the principles of transportation asset management with an emphasis on pavement management system (PMS). Network- and project-level pavement management processes will be discussed, but the emphasis will be on network-level. Bridge management system will also be covered. Prerequisite: ENGR 203 and a statistics course (MATH 321, CHE 315, ECON 210 or approved substitute). F, even years.

CE 418. Pavement Engineering. 3 Credits.
To introduce students to structural pavement design concepts for flexible and rigid pavements, traffic and environmental loading factors, material characterization, stresses and strains in flexible and rigid pavements, joints and load transfer of rigid pavements, and construction issues. CE 518 cannot be taken after completing CE 418. Prerequisite: CE 412. F.

CE 419. Sustainable Pavements. 3 Credits.
To introduce students to pavement sustainability concepts, an overview of mix design, structural design, and construction methods of pavements promoting sustainability concepts, including warm mix asphalts, recycling of asphalt and concrete pavements, perpetual pavements, and specialty pavements. Assessing the environmental, economic, and social impacts of highway pavements by implementing sustainability concepts will also be introduced. In addition to the instructor's lectures, students are required to participate in the presentation and discussion of assigned course material. CE 519 cannot be taken after completing CE 419. Prerequisite: CE 412. S.

CE 421. Hydrology. 3 Credits.
Course topics include measurement, interpretation, analysis and application of hydrologic data; precipitation, evaporation and transpiration; runoff hydrographs; routing methods; groundwater; and snow hydrology. Computer applications. Prerequisite: CE 306 and CE 423. F.

CE 423. Hydraulic Engineering. 3 Credits.
Fluid statics and dynamics; open channel flow; transitions and controls; hydraulic structures; hydraulic machinery; hydraulic power conversion; and hydraulic modeling. Prerequisite: CE 306. S.

CE 423L. Hydraulic Engineering Laboratory. 1 Credit.
The course involves lab experiences designing experiments and fluid properties, flow measurements, open channel flow, pipe flow, and hydraulic machinery. Students perform lab work in teams and communicate results in written reports and one oral presentation. Prerequisite: CE major and ENGL 130. Corequisite: MATH 321 or CHE 315 or ECON 210; and CE 423 and CE 431L. S,SS.

CE 424. Open Channel Hydraulics. 3 Credits.
Study of advanced topics in open channel hydraulics. Computer applications. CE 524 cannot be taken after completing CE 424. Prerequisite: CE 423 or instructor consent. F.

CE 425. Surface Hydrology. 3 Credits.
Extreme rainfalls and flood frequency analysis, regionalization; runoff generations, routings, and basin modeling; urban storm water design; GIS and remote sensing applications in hydrology; recent techniques and development in surface hydrology. CE 525 cannot be taken after completing CE 425. Prerequisite: CE 421 or instructor consent. S.

CE 426. Applied Hydraulics. 3 Credits.
Study of advanced topics on the hydraulics and design of water systems including water supply, water storage, drainage, and flow controls. CE 526 cannot be taken after completing CE 426. Prerequisite: CE 423 or instructor consent. On demand.

CE 431. Principles of Water and Wastewater Treatment. 3 Credits.
Environmental quality, water quality modeling, water wastewater treatment systems, sludge processing, solid wastes, hazardous wastes, environmental law. Prerequisite: CE 306. S.

CE 431L. Environmental Engineering Laboratory. 1 Credit.
The course involves lab experiences designing experiments and water and wastewater treatment topics such as BOD, total and suspended solids, water hardness, chlorination, alkalinity, coagulation, and jar testing. Students perform lab work in teams and communicate results in written reports and one oral presentation. Prerequisite: CE major and ENGL 130. Corequisite: MATH 321 or CHE 315 or ECON 210; and CE 423L and CE 431. S,SS.

CE 432. Environmental Engineering Design. 3 Credits.
Water distribution networks, mass curve analysis, wastewater collection systems, pumping systems for water and wastewater, system design project, computer-assisted design, confined spaces. Prerequisite: CE 423. F.

CE 434. Environmental Engineering Laboratory. 4 Credits.
Physical, chemical and biological methods used in environmental engineering, water chemistry, instrumental methods, lab tours. On demand.

CE 435. Hazardous Waste Management. 3 Credits.
Regulations, generation, storage, transportation, disposal, classification, fate and transport of contaminants, environmental audits, pollution prevention and management facilities, remediation alternatives, physical-chemical treatment, bioremediation, stabilization/solidification, thermal processes. Prerequisite: CE 306 and CHEM 121. S.

CE 436. Environmental Chemistry. 3 Credits.
Water chemistry in unit Operation and process design for water and wastewater treatment; physical, chemical, and biological systems; plant design project, computer-assigned design analysis. Prerequisite: CE 431. F.

CE 437. Unit Operations in Water and Wastewater Treatment. 3 Credits.
Advanced theory and special methods in municipal and industrial water and wastewater processes including treatment plant control, equipment studies, nutrient removal, contaminant fate and transport, and toxic pollutants control. Prerequisite: CE 431. S.

CE 444. Contracts and Specifications. 3 Credits.
Engineering contracts and specification essentials, legal aspects of engineering practice and employment; professional practice issues; procurement of work; governmental regulation. S.

CE 451. Steel Design. 3 Credits.
This course provides students with the knowledge and skills to select structural sections and design members subjected to tension, compression, flexural, and combined compression and flexural loads. It also covers the design of bolted and welded connections, trusses, bearings, light-gauge structural members, and the understanding of fatigue in structural members. Additionally, an introduction to plastic design is included. Prerequisite: CE 351. S.

CE 452. Thin Shell Structures. 3 Credits.
Differential geometry of shell theory, membrane and bending theories of shells, shells of revolution, stress analysis of domes, pressure vessels, and storage tanks, numerical methods, buckling of shells. CE 552 cannot be taken after taking the CE 452. Prerequisite: ENGR 203 and CE 351. F, odd years.

CE 453. Reinforced Concrete. 3 Credits.
Reinforced concrete history, materials properties, strength design method, load factors and strength reduction factors, analysis and strength design of reinforced concrete beams in flexure, analysis and design of beams in shear, bond strength and rebar development length and cutoffs in beams, service design requirement for deflection and crack width control in beams, one-way slab design, analysis and design of short columns under uniaxial and biaxial loading. The design process is based on the ACI 318 building code. Prerequisite: CE 351. F.

CE 455. Prestressed Concrete-Analysis and Design. 3 Credits.
Prestressing motivation and history, prestressed concrete and high strength steel properties, pre-tensioned and post-tensioned members, allowable stress analysis and design of prestressed members in flexure, flexural ultimate design of composite and non-composite beams, pre-stress losses, determination of deflection in prestress beams, shear design of prestressed beams, end zone reinforcement. CE 555 cannot be taken after completing CE 455. Prerequisite: CE 453. On demand.

CE 456. Numerical and Matrix Methods of Structural Analysis. 3 Credits.
Numerical and Matrix Methods of Structural Analysis Methods of successive approximations and numerical procedures for solution of complex structural problems, matrix formulation of structural problems, flexibility and stiffness methods of analysis. CE 556 cannot be taken after taking CE 456. Prerequisite: CE 351. F, odd years.

CE 457. Advanced Steel Design. 3 Credits.
This course covers the design and analysis of simple structural connections, including moment and shear connections, eccentric structural connections, plate girders, and composite structures. It also includes the design and analysis of seismic loads, emphasizing both Allowable Stress Design (ASD) and Load Resistance Factor Design (LRFD). CE 557 cannot be taken after completing CE 457. Prerequisite: CE 451 or consent of the instructor. S.

CE 458. Theory of Plasticity. 3 Credits.
This course rigorously explores classical plasticity theory, encompassing key concepts in continuum mechanics such as stress, strain, and elastic behavior. It progresses to studying plastic behavior in materials, the mathematical formulation of elastoplastic constitutive models, and practical engineering applications, including limit analysis. Students will also apply plasticity theories in computational analysis using specialized software. CE 558 cannot be taken after completing CE 458. Prerequisite: CE 451. F.

CE 459. Plate and Slab Structures. 3 Credits.
Classical plate bending theory, rectangular and circular plates, slab analysis by energy and numerical methods, anisotropic plates, large deflection theory, buckling of thin plates. CE 559 cannot be taken after taking CE 459. Prerequisite: ENGR 203 and CE 351. S, odd years.

CE 482. Civil Engineering Design I. 3 Credits.
This comprehensive design course integrates engineering design and engineering science components of previous and ongoing coursework into a major design experience. Design projects can be environmental, geotechnical, structures, water resources, or transportation engineering. Course activities include defining the problem, formulating project objectives, gathering background information, scheduling the project, applying design standards and multiple realistic constraints, developing design alternatives, and evaluating design alternatives. Other topics covered include concepts and principles in project management and engineering economics, professional attitudes and responsibilities of a civil engineer that include licensure and safety, application of an engineering code of ethics to ethical dilemmas, effective teamwork, an ability to acquire and apply new knowledge as needed, and applications of graphical communication. Group design reports and individual oral presentations are required. Prerequisite: At least one of CE 412 or CE 451, and at least one of CE 423 or CE 431. F.

CE 483. Civil Engineering Design II. 3 Credits.
This comprehensive design course integrates engineering design and engineering science components of previous and ongoing coursework into a major design experience. Course activities include developing and analyzing a detailed design, preparing plans and drawings using graphical communication tool(s), developing design specifications, and estimating construction costs. Other topics include the application of the principles of sustainability, risk, resilience, diversity, equity, and inclusion to civil engineering problems and applying global, cultural, social, environmental, and economic factors. Group design reports and individual oral presentations are required. Prerequisite: CE 482 or departmental consent. S.

CE 490. Special Topics. 1-3 Credits.
Investigation of special topics dictated by student and faculty interests. Repeatable. Prerequisite: Department approval. Repeatable. F,S.

CE 501. Mechanics of Materials II. 3 Credits.
This course covers stress and strain theories in two and three dimensions, including transforming stresses and strains. Topics include tensor notation, linear and nonlinear stress-strain behavior, thermal stresses, and material behavior in isotropic, orthotropic, and anisotropic materials. The course also addresses yield criteria and failure theories under combined stresses, energy methods, torsion of noncircular and thin-walled sections, unsymmetrical bending, the shear center, and curved beams. CE 501 cannot be taken after completing CE 401. Prerequisite: Background/knowledge of mechanics of materials; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. S, odd years.

CE 502. Structural Stability. 3 Credits.
This course covers the concept of stability and the application of equilibrium and energy methods in structural analysis. Topics include the stability of columns, beam-columns, frames, and inelastic buckling. It also explores stability analysis using slope-deflection and matrix methods and the use of codes for the stability design of aluminum and steel columns and frames. Additional topics include torsional and lateral-torsional buckling of beams and beam-columns. CE 502 cannot be taken after completing CE 402. Prerequisite: Background/knowledge of mechanics of materials; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. On demand.

CE 503. Structural Dynamics. 3 Credits.
Introduction to vibration and dynamics, single degree freedom free vibration, single degree freedom forced vibration, harmonic and periodic excitations; pulse, introduction to viscous and non-viscous damping system, dynamic system identification, numerical methods to determine dynamic response; determination of earthquake response of linear elastic buildings; dynamics of generalized single degree of freedom systems, dynamics of shear buildings, dynamics of multi-degree of freedom systems, modal superposition, modal spectral analysis, structural dynamics in US building code. CE 503 cannot be taken after completing CE 403. Prerequisite: Background/knowledge of computer applications in engineering, structural mechanics and dynamics; additional info is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. On demand.

CE 509. Traffic Engineering: Operations. 3 Credits.
The course is designed to provide information on basic characteristics of traffic, including drivers, vehicles, volumes, speeds, delay, origins and destinations, traffic control devices, intersection performance, capacity, techniques for making traffic engineering investigations, techniques of conducting traffic studies, traffic laws and ordinances, regulations, design and application of signal systems, curb parking control, and CAV technologies impact on road capacities and mobility. CE 509 cannot be taken after completing CE 409. Prerequisite: Background/knowledge of transportation engineering; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. S.

CE 513. Traffic Safety. 3 Credits.
This course introduces students to fundamental concepts in traffic safety analysis, equipping them with the skills to assess and improve safety in transportation systems. Students will write a research paper on a topic related to traffic safety and develop the ability to analyze crash data using different methodologies. CE 513 cannot be taken after completing CE 413. Prerequisite: Background/knowledge of transportation engineering; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. F.

CE 514. Foundation Engineering. 3 Credits.
Soil improvements and ground modifications, soil exploration and sampling, bearing capacity, spread footings, mat foundations, settlement analysis, drilled shaft and pile foundations, foundations on difficult soil. Prerequisite: Background/knowledge of soil mechanics; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. S.

CE 515. Asphalt Mix Design and Construction. 3 Credits.
This course focuses on the characterization of asphalt materials and mixtures, hot mix asphalt design, analysis, construction concepts, and the Superpave mix design method. It will also discuss balanced mix design, pavement distress mechanisms and performance testing, and recent developments in asphalt technology. CE 515 cannot be taken after completing CE 415. Prerequisite: Background/knowledge of soil mechanics and transportation engineering; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. S.

CE 517. Transportation Asset Management. 3 Credits.
Course focused on the principles of transportation asset management with an emphasis on pavement management system (PMS). Network- and project-level pavement management processes will be discussed, but the emphasis will be on network-level. Bridge management system will also be covered. Prerequisite: Background/knowledge of mechanics of materials and statistics; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. F, even years.

CE 518. Pavement Engineering. 3 Credits.
To introduce students to structural pavement design concepts for flexible and rigid pavements, traffic and environmental loading factors, material characterization, stresses and strains in flexible and rigid pavements, joints and load transfer of rigid pavements, and construction issues. CE 518 cannot be taken after completing CE 418. Prerequisite: Background/knowledge of soil mechanics; additional information is available in the CE Graduate Student Handbook on the CE Department website and graduate student blackboard site; consent of instructor for undergraduate students. F.

CE 519. Sustainable Pavements. 3 Credits.
To introduce students to pavement sustainability concepts, an overview of mix design, structural design, and construction methods of pavements promoting sustainability concepts, including warm mix asphalts, recycling of asphalt and concrete pavements, perpetual pavements, and specialty pavements. Assessing the environmental, economic, and social impacts of highway pavements by implementing sustainability concepts will also be introduced. In addition to the instructor's lectures, students are required to participate in the presentation and discussion of assigned course material. CE 519 cannot be taken after completing CE 419. Prerequisite: Background/knowledge of soil mechanics; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. S.

CE 521. Hydrology. 3 Credits.
Course topics include measurement, interpretation, analysis and application of hydrologic data; precipitation, evaporation and transpiration; runoff hydrographs; routing methods; groundwater; and snow hydrology. Computer applications. Prerequisite: Background/knowledge of fluid mechanics and hydraulic engineering; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. F.

CE 523. Hydraulic Engineering. 3 Credits.
Fluid statics and dynamics; open channel flow; transitions and controls; hydraulic structures; hydraulic machinery; hydraulic power conversion; and hydraulic modeling. Prerequisite: Background/knowledge of fluid mechanics; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. S.

CE 524. Open Channel Hydraulics. 3 Credits.
Study of advanced topics in open channel hydraulics. Computer applications. CE 524 cannot be taken after completing CE 424. Prerequisite: Background/knowledge of hydraulic engineering; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. F.

CE 525. Surface Hydrology. 3 Credits.
Extreme rainfalls and flood frequency analysis, regionalization; runoff generations, routings, and basin modeling; urban storm water design; GIS and remote sensing applications in hydrology; recent techniques and development in surface hydrology. CE 525 cannot be taken after completing CE 425. Prerequisite: Background/knowledge of hydrology; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. S.

CE 526. Applied Hydraulics. 3 Credits.
Study of advanced topics on the hydraulics and design of water systems including water supply, water storage, drainage, and flow controls. CE 526 cannot be taken after completing CE 426. Prerequisite: Background/knowledge of hydraulic engineering; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. On demand.

CE 531. Principles of Water and Wastewater Treatment. 3 Credits.
Environmental quality, water quality modeling, water wastewater treatment systems, sludge processing, solid wastes, hazardous wastes, environmental law. Prerequisite: Background/knowledge of fluid mechanics; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. S.

CE 532. Environmental Engineering Design. 3 Credits.
Water distribution networks, mass curve analysis, wastewater collection systems, pumping systems for water and wastewater, system design project, computer-assisted design, confined spaces. Prerequisite: Background/knowledge of fluid mechanics; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. F.

CE 533. Industrial Wastes. 3 Credits.
Industrial processes and waste characterization, regulatory law, specialized treatment systems, hazardous wastes, economic analysis; plant tours of potato, sugar, meat, dairy, paper and pulp products and metal plating industries. Prerequisite: CE 431.

CE 535. Hazardous Waste Management. 3 Credits.
Regulations, generation, storage, transportation, disposal, classification, fate and transport of contaminants, environmental audits, pollution prevention and management facilities, remediation alternatives, physical-chemical treatment, bioremediation, stabilization/solidification, thermal processes. Prerequisite: CE 306 and CHEM 121.

CE 536. Environmental Chemistry. 3 Credits.
Water chemistry in unit Operation and process design for water and wastewater treatment; physical, chemical, and biological systems; plant design project, computer-assigned design analysis. Prerequisite: Background/knowledge of introductory environmental engineering; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. F.

CE 537. Unit Operations in Water and Wastewater Treatment. 3 Credits.
Advanced theory and special methods in municipal and industrial water and wastewater processes including treatment plant control, equipment studies, nutrient removal, contaminant fate and transport, and toxic pollutants control. Prerequisite: Background/knowledge of introductory environmental engineering; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. S.

CE 551. Plate and Slab Structures. 3 Credits.
Classical plate bending theory, rectangular and circular plates, slab analysis by energy and numerical methods, anisotropic plates, large deflection theory, buckling of thin plates. Prerequisite: ENGR 203 and CE 351.

CE 552. Thin Shell Structures. 3 Credits.
Differential geometry of shell theory, membrane and bending theories of shells, shells of revolution, stress analysis of domes, pressure vessels, and storage tanks, numerical methods, buckling of shells. Prerequisite: ENGR 203 and CE 351.

CE 555. Prestressed Concrete-Analysis and Design. 3 Credits.
Prestressing motivation and history, prestressed concrete and high strength steel properties, pre-tensioned and post-tensioned members, allowable stress analysis and design of prestressed members in flexure, flexural ultimate design of composite and non-composite beams, pre-stress losses, determination of deflection in prestress beams, shear design of prestressed beams, end zone reinforcement. CE 555 cannot be taken after completing CE 455. Prerequisite: Background/knowledge of reinforced concrete; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. On demand.

CE 556. Numerical and Matrix Methods of Structural Analysis. 3 Credits.
Methods of successive approximations and numerical procedures for solution of complex structural problems, matrix formulation of structural problems, flexibility and stiffness methods of analysis. Prerequisite: CE 351.

CE 557. Advanced Steel Design. 3 Credits.
This course covers the design and analysis of simple structural connections, including moment and shear connections, eccentric structural connections, plate girders, and composite structures. It also includes the design and analysis of seismic loads, emphasizing both Allowable Stress Design (ASD) and Load Resistance Factor Design (LRFD). CE 557 cannot be taken after completing CE 457. Prerequisite: Background/knowledge of steel design; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. S.

CE 558. Theory of Plasticity. 3 Credits.
This course rigorously explores classical plasticity theory, encompassing key concepts in continuum mechanics such as stress, strain, and elastic behavior. It progresses to studying plastic behavior in materials, the mathematical formulation of elastoplastic constitutive models, and practical engineering applications, including limit analysis. Students will also apply plasticity theories in computational analysis using specialized software. CE 558 cannot be taken after completing CE 458. Prerequisite: Background/knowledge of steel design; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. F.

CE 559. Plate and Slab Structures. 3 Credits.
Classical plate bending theory, rectangular and circular plates, slab analysis by energy and numerical methods, anisotropic plates, large deflection theory, buckling of thin plates. Prerequisite: ENGR 203 and CE 351. S, odd years.

CE 562. Graduate Seminar in Civil Engineering. 1 Credit.
Conference and reports on current developments in Civil Engineering. Prerequisite: Admission to Civil Engineering Graduate Program. Repeatable to 3.00 credits. S/U grading. F,S,SS.

CE 590. Special Topics. 1-15 Credits.
Investigation of special topics dictated by student and faculty interests. May be repeated up to a total of 15 credits. Prerequisite: Department approval. Repeatable to 6.00 credits. F,S,SS.

CE 591. Civil Engineering Research. 1-15 Credits.
May be repeated to a maximum of 15 credits. Repeatable to 12.00 credits. F,S,SS.

CE 595. Design Project. 3-6 Credits.
A three to six credit course of engineering design experience involving individual effort and formal written report. Repeatable to 6 credits. Prerequisite: Restricted to the Master of Engineering student candidate and subject to approval by the student's advisor. Repeatable to 6.00 credits.

CE 597. Graduate Cooperative Education. 1-2 Credits.
A practical work experience with an employer closely associated with the student's academic area. Arranged by mutual agreement among student, department, and employer. Prerequisite: Approval of CE Graduate Director or major advisor. Repeatable to 4.00 credits. S/U grading. On demand.

CE 599. Doctoral Research. 1-18 Credits.
Research contributing to the discovery and dissemination of knowledge and/or technology in Civil Engineering and contributing to the student's doctoral dissertation. Prerequisite: Admission to the PhD in Civil Engineering Program. Repeatable. F,S,SS.

CE 996. Continuing Enrollment. 1-12 Credits.
Repeatable. S/U grading.

CE 997. Independent Study. 2 Credits.
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CE 998. Thesis. 1-9 Credits.
Development and documentation of scholarly activity demonstrating proficiency in Civil Engineering at the master's level. Repeatable to 9 credits. Repeatable to 9.00 credits.

CE 999. Dissertation. 1-18 Credits.
PhD student doctoral dissertation. Prerequisite: Admission to the PhD in Civil Engineering Program. Repeatable to 18.00 credits. S/U grading. F,S,SS.