CIVIL ENGINEERING (CE)

CE 1A. Civil Engineering Seminar. 1 Unit
Introduces students to civil engineering as a profession. Topics include the technical disciplines (environmental, geotechnical, structural, transportation, and water resources), the role of civil engineers in planning, constructing and operating infrastructure, and professional responsibilities such as licensure and ethics. Case studies are used to explore both technical and nontechnical aspects of civil engineering projects such as design and environmental constraints, constructability, and social and political issues.

CE 4. Engineering Graphics and CAD. 2 Units
In-depth graphic analysis and solution of typical three dimensional space problems by applying the principles of orthogonal projection. Fundamentals of interactive computer aided design and drafting. Lecture one hour; laboratory three hours.

CE 9. Plane and Topographic Surveying. 3 Units
Prerequisite(s): MATH 26A or MATH 30; may be taken concurrently.
Instruments, methods and theories necessary for the measurement of distance, direction, angles and elevations. Application of data to traverse computations, estimation of earthwork volumes, transportation facility design and construction layout. Introduction to legal aspects of surveying, geodetic surveys, maps, boundary surveys and new technologies used in surveying. Lecture two hours; laboratory three hours.

CE 100. Engineering Geology. 2 Units
Prerequisite(s): ENGR 112; may be taken concurrently.
Soil and rock mechanics and their relations to geological features influencing design, construction and maintenance of engineering projects. Lectures and field problems.

CE 101. Computer Applications in Civil Engineering. 3 Units
Prerequisite(s): ENGR 30 and CE 4 (CE 4 may be taken concurrently).
Develops a computer-based concept for problem solving and graphical presentation of results with applications in five areas of civil engineering: environmental, geotechnical, structural, transportation and water resources. Uses word processing, spreadsheets, structure programming (Visual BASIC with spreadsheets), and special purpose software packages. Lecture two hours; laboratory three hours.

CE 113. Structural Laboratory. 1 Unit
Prerequisite(s): CE 101 and ENGR 112; WPJ score of 70+, or at least a "C-" in ENGL 109M or ENGL 109W.
Introduction to the principles of structural analysis and design by testing of structural elements. Experimental verification of the assumptions of strength of materials. Introduction to laboratory techniques. Laboratory three hours.

CE 135. Hydraulics Laboratory. 1 Unit
Prerequisite(s): CE 101, CE 137 and CE 146; CE 137 and CE 146 may be taken concurrently
Laboratory experiments relating the principles of fluid mechanics to real fluid flow. Laboratory three hours.

CE 137. Water Resources Engineering. 3 Units
Prerequisite(s): CE 1A, CE 101, CE 146, ENGR 115, ENGR 132, and ENGR 140; CE 146 may be taken concurrently.
Hydrologic and hydraulic fundamentals which are common to water resources projects; introduction to reservoirs, dams, pipelines, channels, hydraulic machinery, ground water, water rights, statistical analysis, engineering economy applications, and water resources planning.

CE 138. Hydrology. 3 Units
Prerequisite(s): CE 137.
Introduction to hydrologic engineering design. Precipitation analysis, hydrograph and flood routing applications for civil engineering. Groundwater hydrology including quality problems in development of subsurface water resources. Statistical applications in hydrology.

CE 139. Open Channel Hydraulics. 3 Units
Prerequisite(s): CE 137.
Civil engineering design problems in open channel flow. Model design, pressure problems, design application of hydraulic analysis in structures, transitions, culverts, weirs and spillways. Channel design including roughness for subcritical and supercritical flow. Analyzes and design problems in steady, uniform, gradually and rapidly varied flow.

CE 146. Civil Engineering Professional Practice. 3 Units
Prerequisite(s): CE 1A and ENGR 30; GWAR; CE 1A may be taken concurrently.
Corequisite(s): CE 1A.
Introduction to the legal and business environment of professional engineering practice, including legal responsibilities of professionals, ethics, risk and liability, types and use of contracts, specifications, the construction bid process, and environmental responsibilities. Elements of engineering organizations such as business economics, human resources, and project management.

CE 147. Transportation Engineering. 4 Units
Prerequisite(s): CE 1A, CE 9, CE 101, CE 146, ENGR 115; CE 146 may be taken concurrently
Introduction to the fundamental topics in Transportation Engineering. Focus on roadway geometric design, layout considerations, pavement materials and design, traffic operations and analysis. Lecture three hours; laboratory three hours.

CE 148. Transportation Systems. 3 Units
Prerequisite(s): CE 147, ENGR 140 or instructor permission, and (GWAR certification before Fall 09, or WPJ score of 70+, or at least a C- in ENGL 109M or ENGL 109W).
Transportation systems evaluation and management. Focus on transportation planning methods, including data analysis, estimation of future demand, evaluation of travel demand impacts on existing systems, and transportation system decision-making.

CE 149. Traffic Analysis and Design. 3 Units
Prerequisite(s): CE 147
Introduction to the fundamental principles of traffic operations, traffic data collection methods, intersection control, signal design and analysis techniques. Methods and software for designing and optimizing signalized and unsignalized intersection operation. This course may be paired with CE 265.

CE 151. Introduction to GIS in Civil Engineering. 3 Units
Prerequisite(s): ENGR 115, CE 9, and either CE 137, CE 147, CE 170, or CE 171A.
Fundamental geographic information system (GIS) concepts; GIS data acquisition and analysis; GIS analytical methods. Lab exercises with GIS software used to introduce students to typical uses of GIS in civil engineering. This course may be paired with CE 296H. Lecture two hours; lab three hours.

CE 161. Introduction to Structural Analysis. 3 Units
Prerequisite(s): CE 1A, CE 101, CE 146, ENGR 112, and MATH 35 or MATH 100. CE 146 may be taken concurrently.
Analysis of statically determinate and indeterminate beams, frames, and trusses. Includes energy principles, flexibility and stiffness analyses, and influence lines. Computers are used to aid in the solution of complex structural problems.

CE 162. Advanced Structural Analysis. 3 Units
Prerequisite(s): CE 161.
Analyzes continuous beams and plane frames by moment distribution and direct stiffness methods. Use of symmetry in structures. Temperature, support displacement, misfit effects, and non-prismatic members. Extensive use of computer programs. Introduction to applications of matrix condensation and finite element analysis.

CE 163. Structural Design in Steel I. 3 Units
Prerequisite(s): CE 161.
Theory and practice in design of structural steel members and connections using current design specifications. Design of tension and compression members, laterally supported and unsupported beams, beam-columns, and bolted and welded connections. Use of microcomputers in design.

CE 164. Reinforced Concrete Design. 3 Units
Prerequisite(s): CE 113, CE 161; CE 113 may be taken concurrently.
Theory and practice in design of reinforced concrete beams, slabs, columns, footings and retaining walls. Includes study of design, preparation and testing of cements, aggregates and concrete mixtures.

CE 165. Structural Design in Steel II. 3 Units
Prerequisite(s): CE 163.
Continuation of CE 163. Torsion analysis and design of wide-flange beams. Analyzes and design of heavy industrial structures such as plate girders and crane girders, braced and unbraced frames. Composite floors.

CE 166. Seismic Behavior of Structures. 3 Units
Prerequisite(s): CE 101, CE 161, ENGR 110.
Analyzes simple structures' response to dynamic loads with emphasis on response to earthquake ground motion. Introduction to multi-story buildings dynamics. Modal and approximate analyses of earthquake response. Dynamic analysis and building code procedures.

CE 168. Pre-stressed Concrete Design. 3 Units
Prerequisite(s): CE 161, CE 164; CE 164 may be taken concurrently.
Analyzes and design of pre-stressed concrete structures using ultimate strength and working stress methods. Detailed study of stress-strain behavior of P.C. members. Study of bond and shear. An introduction to least-weight design.

CE 169A. Timber Design. 3 Units
Prerequisite(s): CE 161.
Wood as a structural material. Design of sawn and glulam beams, concentrically and eccentrically loaded columns, shear walls, flexible diaphragms and connections for vertical and lateral loading including effects of wind and seismic forces.

CE 169B. Reinforced Masonry Design. 3 Units
Prerequisite(s): CE 161.
Reinforced masonry as a structural material. Design of reinforced masonry beams, concentrically and eccentrically loaded columns, walls for vertical and lateral loading including effects of wind and seismic forces. Design of a small building for wind and seismic loading including torsional effects.

CE 170. Principles of Environmental Engineering. 4 Units
Prerequisite(s): CHEM 1E or CHEM 1A, CE 1A, CE 101, CE 146, ENGR 115; CE 146 may be taken concurrently
Introduction to the principles and practices of environmental quality management. Physical and chemical principles affecting environmental quality. Water and air quality parameters, their importance, and natural processes that affect them. Introduction to treatment processes and waste management. Environmental ethics. Lecture three hours. Laboratory three hours.

CE 171A. Soil Mechanics. 4 Units
Prerequisite(s): CE 1A, CE 100, CE 101, CE 146, and ENGR 112. CE 146 may be taken concurrently.
Composition and properties of soils; soil classification; soil compaction; soil-water interaction, including permeability and seepage analyses; soil stresses; soil compressibility, consolidation, and settlement analysis; soil shear strength. Lecture three hours; laboratory three hours.

CE 171B. Soil Mechanics and Foundation Engineering. 3 Units
Prerequisite(s): CE 171A.
Lateral earth pressures and principles of retaining wall design; slope stability analysis and principles of slope stabilization design; ultimate bearing capacity of soils, allowable bearing pressures and settlement of structures; principles of foundation design including shallow foundations and deep foundations.

CE 172. Design of Urban Water and Sewer Systems. 3 Units
Prerequisite(s): CE 137.
Hydraulic design of water distribution and sewerage systems. Computer-assisted pipe network analysis. Analysis of pump systems. Pump station design. Other selected topics.

CE 173. Design of Water Quality Control Processes. 3 Units
Prerequisite(s): CE 170, ENGR 132.
Analysis and design of selected physical, chemical, and biological facilities for water purification and wastewater treatment. Emphasis is on design based on loading factors and integration of unit processes into treatment systems.

CE 181. Geoenvironmental Engineering. 3 Units
Prerequisite(s): CE 170 and CE 171A; CE 170 may be taken concurrently
Equilibrium distribution of contaminants among air, water and solid phases of soil systems; analysis and modeling of soil vapor extraction (SVE), pump and treat, and soil washing systems; movement of gasses in landfills; infiltration through landfill cover; geosynthetic liner systems; hazardous waste containment systems.

CE 184. Geotechnical Earthquake Engineering. 3 Units
Prerequisite(s): CE 171A.
Introduction to seismology and seismic hazard analysis; determination of building code design loads; prediction of soil-site effects; evaluation of liquefaction triggering, cyclic softening and associated consequences; introduction to mitigation techniques for liquefaction and ground failure hazards.

CE 190. Senior Project. 3 Units
Prerequisite(s): To be taken in final semester or instructor permission.
Culminating degree requirement. Completion of a conceptual design and evaluation of alternatives under realistic constraints for proposed infrastructure projects. Students work in teams with practicing professionals providing mentoring. Draws upon full educational experience to date. Lecture two hours. Laboratory three hours.

CE 194. Career Development in Civil Engineering. 1 Unit
Prerequisite(s): Instructor permission.
Designed for Civil Engineering students making career decisions. Instruction will include effective career planning strategies and techniques including skill assessments, employment search strategy, goal setting, time management, interview techniques and resume writing. Lecture one hour.
Note: Units earned cannot be used to satisfy major requirements. Cross Listed: ENGR 194, EEE194

Credit/No Credit

CE 195. Fieldwork in Civil Engineering. 1 - 3 Units
Prerequisite(s): Petition approval by supervising faculty member and Department chair.
Supervised work experience in civil engineering with public agencies or firms in the industry.
Note: May be repeated for credit.

Credit/No Credit

CE 195A. Professional Practice. 1 - 12 Units
Prerequisite(s): Instructor permission.
Supervised employment in a professional engineering or computer science environment. Placement arranged through the College of Engineering and Computer Science.
Note: Requires satisfactory completion of the work assignment and a written report.

Credit/No Credit

CE 199. Special Problems. 1 - 3 Units
Individual projects or directed reading.
Note: Open to students judged capable of carrying out individual work. Admission requires departmental approval and sponsorship of a supervising faculty member. Cannot be used as a technical elective in the major. Consult the CE Department for admission procedures and other requirements. May be repeated.

CE 199E. Independent Study Technical Elective. 3 Units
Prerequisite(s): GPA of 2.5 or greater in the upper division courses of the major; grade of "B" or better in the required major course associated with the proposed area of study (CE 137 or CE 146 or CE 147 or CE 161 or CE 170 or CE 171A).
Individual project, research, or directed reading on an advanced topic.
Note: Open to only those students prepared and capable of carrying out independent work. Admission requires departmental approval and sponsorship of a supervising faculty member. Can be used as a technical elective in the major. Consult the CE Department for admission procedures and other requirements. May not be repeated for credit.

CE 231A. Computer Methods of Structural Analysis I. 3 Units
Prerequisite(s): CE 161.
Flexibility and stiffness methods of structural analysis are applied to two- and three-dimensional framed structures. Use of computer software to perform analysis is discussed in detail. Techniques of computer modeling are discussed.

CE 231B. Computer Methods of Structural Analysis II. 3 Units
Prerequisite(s): CE 231A or instructor permission.
Continuation of CE 231A with extension of theory to allow for the analysis of a wider variety of structures. Structural analysis software is used for the analysis of three-dimensional structures. Fundamentals of the finite element method and computer modeling with applications to structural problems.

CE 232. Nonlinear Structural Analysis. 3 Units
Prerequisite(s): CE 231A or instructor permission.
Theory and applications of nonlinear structural analysis including geometric and material nonlinear effects. Stability issues and second-order analysis methods in the context of moment amplification effects, member buckling, and the behavior of structural elements and frames undergoing large deformations. Inelastic material behavior and stress resultant plasticity concepts within a line-type element framework. Computer implementation of geometric nonlinear behavior.

CE 234. Dynamics and Earthquake Response of Structures. 3 Units
Prerequisite(s): Knowledge of the stiffness method of structural analysis.
Response of structures modeled as single-degree systems to harmonic, periodic, and arbitrary excitation and earthquake ground motion; effects of damping and material nonlinearity; numerical methods using spreadsheets; response spectra. Response of structures modeled as multi-degree systems: modeling of structure mass, damping and elastic stiffness; solution by modal superposition; time-history and response spectrum analysis; implications for codes for earthquake-resistant design. Microcomputer software is extensively used.

CE 235. Advanced Steel Design. 3 Units
Prerequisite(s): CE 163
Advanced design methodology of steel structures using Load and Resistance Factor Design (LRFD). System level behavior, especially from a seismic loading perspective, is integrated into the design of steel components and connections. Other topics include plate girder design, plastic design of indeterminate systems, design of moment frame systems, and design of braced-frame systems.

CE 250. Systems Analysis of Resources Development. 3 Units
Prerequisite(s): Graduate status or instructor permission.
Investigation of resource planning using the "systems approach". Objectives of resource development; basic economic and technologic concepts, and economic factors affecting system design. Consideration of evaluation, institutional constraints, and uncertainty in water resources systems. Familiarization with modern computer techniques. Applications of concepts to air and land resources.

CE 251. Water Resources Planning. 3 Units
Prerequisite(s): CE 250 or instructor permission.
Application of single and multi-objective planning to the design and operation of water resources projects. Objectives and constraints for water projects, criteria and procedures for evaluation, planning under uncertainty. Application in water development and water quality planning, with case studies.

CE 252A. Environmental Quality Processes I. 3 Units
Prerequisite(s): CE 170 or equivalent.
Theory and practice of chemical processes affecting water quality. Chemical equilibrium, stoichiometry and kinetics of aqueous chemistry. Acid-base, precipitation-dissolution, oxidation-reduction, and coordination chemistry. Adsorption.

CE 252B. Environmental Quality Processes II. 3 Units
Prerequisite(s): CE 170 or equivalent, CE 252A recommended, or instructor permission.
Theory and practice of biological processes for controlling water. Stoichiometry and kinetics of microbial growth. Aerobic and anaerobic metabolism. Engineered suspended and attached growth systems. Introduction to sludge treatment.

CE 252C. Environmental Quality Processes III. 3 Units
Prerequisite(s): CE 170 or equivalent, CE 252A recommended, or instructor permission.
Theory and practice of physical and chemical processes used in engineered water and wastewater systems. Adsorption, ion exchange, gas transfer, membrane processes, coagulation, flocculation, sedimentation, filtration, precipitation, disinfection, and stripping. Physical/chemical reactors.

CE 254. Water Quality Management. 3 Units
Prerequisite(s): CE 170 or equivalent, CE 252A recommended, or instructor permission.
Examination of pollution sources and effects on water bodies, and the management issues and tools used to protect environmental quality. Topics include point and nonpoint pollution sources, interactions in the environment, Federal and State laws, water quality objectives, beneficial uses, and regulatory mechanisms such as basin plans and total maximum daily loads (TMDLs). Emphasis is on surface water.

CE 255. Transport of Chemicals in Soil Systems. 3 Units
Prerequisite(s): MATH 45. Graduate status.
Study of the mechanics of movement of chemicals in soil, including equilibrium and partition models, development of mass transport equations in porous media, analytical solution for one-dimensional transport, lumped parameter transport model (linear reservoir model), transport of reactive and conservative chemicals numerical solutions of transport models, transport in the unsaturated zone and coupled models for saturated and unsaturated zone.

CE 261. Transportation Planning. 3 Units
Prerequisite(s): CE 148 or instructor permission.
Introduction to the complexities of comprehensive intermodal transportation planning. Study of transportation problems, system operating characteristics, alternative modes, and the planning process. Analyzes factors affecting travel behavior and methods of forecasting demand for travel by various modes.

CE 262. Advanced Transportation Facility Design. 3 Units
Prerequisite(s): CE 147 or instructor permission.
Advanced study of current topics in highway and mass transportation facility design including safety, curve design, pavement design and drainage facility design. Focuses on current design practice and recent or impending changes in design practice.

CE 263. Traffic Flow Theory. 3 Units
Prerequisite(s): CE 147 or CE 148; ENGR 203 or instructor permission.
Study of traffic flow characteristics including flow rate, speed, and density, at both the microscopic and macroscopic levels. Traffic flow analysis using the theoretical methods including capacity analysis, traffic stream models, shockwave analysis, and queuing analysis. Emphasis is on theory with demonstration of practical applications.

CE 265. Analysis and Control of Traffic Systems. 3 Units
Prerequisite(s): CE 147 or CE 148; CE 263 or instructor permission.
Traffic data collection and analysis, practical application of theoretical methods of analysis such as capacity, level of service, and queuing theory. Investigation of traffic control techniques such as actuated signals and signal systems, and study of management techniques for traffic congestion.

CE 266. Advanced Design in Reinforced Concrete. 3 Units
Prerequisite(s): CE 161, CE 163, CE 164.
Advanced topics in behavior and design in reinforced concrete. Detailing for seismic response.

CE 267. Structural Systems for Buildings. 3 Units
Prerequisite(s): CE 232 or instructor permission.
Analyzes and design of various structural systems for buildings: frames, tubes, shear walls with or without openings and interaction between these types. Secondary effects such as P^, material and geometrical nonlinearities.

CE 268. Pre-stressed Concrete Bridge Design. 3 Units
Prerequisite(s): CE 164 or instructor approval.
Behavior and design of short and medium-span prestressed concrete bridges using American Association of State Highway and Transportation Officials (AASHTO) Load Resistance Factor Design (LRFD) specifications. Topics include: bridge types, aesthetics; design process; superstructure load types and live load analysis; limit states and load combinations; prestressed concrete materials; flexural analysis and design; shear analysis and design; and introduction to substructure analysis and design, including seismic design criteria. A team project is required.

CE 271. Modern Hydrologic Techniques. 3 Units
Prerequisite(s): CE 137 or CE 138 and ENGR 203 or instructor permission.
Analyses of hydrologic and meteorologic phenomena by mathematical, statistical, and system methods, linear and non linear, stochastic and parametric hydrology, computer applications in hydrology.

CE 272. Advanced Engineering Hydraulics. 3 Units
Prerequisite(s): CE 137 or equivalent.
Steady uniform and non-uniform open channel flows including gradually, rapid and spatially varied flows; analysis of supercritical flow in transition; basic principles of unsteady flows; long wave theory; Saint-Venant Equations and their solutions including method of characteristics, explicit and implicit finite difference numerical methods.

CE 274. Hydrologic Modeling. 3 Units
Prerequisite(s): CE 272 or equivalent; instructor permission.
Theories and structure of hydraulic model components; application of HEC-RAS (River Analysis System) and HEC-HMS (Hydrologic Modeling System) computer programs; emphasis on flood routing methods; dam safety analysis methodology including dam break and dam overtopping cases; application of microcomputers in hydraulics computations.

CE 276. Groundwater Hydrology. 3 Units
Prerequisite(s): CE 137 or instructor permission.
Occurrence and movement of groundwater; physical characteristics of aquifers; analysis of steady-state groundwater flow problems by mathematical, digital computer, electrical analog and graphical methods; analysis of unsteady-state problems in confined and unconfined, aquifers; multiple well systems.

CE 280A. Advanced Soil Mechanics and Foundation Engineering I. 3 Units
Prerequisite(s): CE 171A or equivalent.
Advanced analyses in soil mechanics and their practical applications in foundation engineering; compressibility of soils, settlement analysis, and tolerable settlement; lateral earth pressures and design of earth retaining structures; bearing capacity of shallow foundations; in-situ soil testing for foundation design; design of deep foundations, including driven piles, drilled shaft foundations, and laterally loaded piles.

CE 280B. Advanced Soil Mechanics and Foundation Engineering II. 3 Units

Prerequisite(s): CE 171A or equivalent.
Advanced analyses in shear strength of cohesionless and cohesive soils, including stress-strain characteristics of soils, total and effective stress analyses; slope stability analyses for natural slopes, fill slopes, earth dams, levees, and methods of slope stabilization; analysis and design of anchored bulkheads, cellular cofferdams, soil nail walls, tieback walls, mechanically stabilized earth walls, and segmental retaining walls.

CE 280C. Geotechnical Modeling. 3 Units

Prerequisite(s): CE 171A
Advanced analysis principles and procedures for calculating monotonic and cyclic soil element response effective stress and pore water pressure distributions, dynamic site response, and soil deformations; application to analysis of complex geotechnical engineering systems such as levees, dams, and wharfs. Laboratory time devoted to numerical analysis software and physical element and small scale tests. Lecture two hours. Laboratory three hours.

CE 283. Ground Modification Engineering. 3 Units

Prerequisite(s): CE 171A or equivalent.
Principles of soil stabilization and earth reinforcement; mechanical compaction and treatment of difficult soils, including expansive soils, collapsible soils, oversize materials, and compressible fill; prefabricated vertical drains and preloading; dynamic deep compaction; vibro compaction; vibro-replacement; rammed aggregate pier; compaction grouting; jet grouting; slurry grouting; chemical grouting; deep soil mixing; slurry trench walls.

CE 284. Soil Dynamics and Earthquake Engineering. 3 Units

Prerequisite(s): CE 171A or equivalent.
Introduction to vibration theory; wave propagation in soils and dynamic behavior of soils and foundations; dynamic tests; analysis of dynamically loaded foundations; causes of earthquakes; earthquake magnitude and zones; ground motions induced by earthquakes; earthquake-resistant design of foundations and earth dams.

CE 285. Geosynthetics I. 3 Units

Prerequisite(s): CE 171A or instructor permission.
Overview of geotextiles, geogrids and geonets; geosynthetic properties and test methods; geosynthetic functions and mechanisms as in separation, roadway and soil reinforcement, filtration, and drainage; applications and design methods; construction, fabrication and installation.

CE 286. Geosynthetics II. 3 Units

Prerequisite(s): CE 171A or instructor permission.
Overview of geomembranes, geosynthetic clay liners, and geocomposities. Topics include: geosynthetic properties and test methods; geosynthetic functions and mechanisms as in landfill liners, liquid barriers and carriers, erosion control, drainage, and design and construction methods.

CE 289. Project Management for Civil Engineers. 3 Units

Prerequisite(s): Graduate standing or instructor permission.
Theory and practice of project management in civil engineering. Interrelationship of planning, design, and construction. New technologies and techniques used in both US and international architectural/engineering/construction (A/E/C) markets.Topics: Project initiation, early estimates, project budgeting, work plans, design proposals, scheduling, tracking, design coordination, construction, project close-out, team and personal management skills, and quality control.

CE 296D. Stormwater Management. 3 Units

Prerequisite(s): CE 137 and CE 170
Principles and practices of stormwater management. Physical and chemical principles affecting stormwater quality, environmental effects, and treatment. Regulatory purposes and requirements for managing construction and post-construction runoff. Choosing and designing Best Management Practices. Erosion control. Hydrologic and hydraulic design of small drainage systems. Emphasis on California climatic and regulatory conditions.

CE 296H. GIS Applications in Civil Engineering. 3 Units

Prerequisite(s): ENGR 115, CE 9 and CE 137 or CE 147 or CE 171A.
Introduction to fundamental concepts of geographic information systems (GIS), methods, and applications in civil engineering. Design and develop GIS-based analytical methods and solutions for civil engineering problems. Lab exercises are used to design and practice GIS applications in civil engineering. This course may be paired with CE 196H.

CE 296I. Pavement Design and Evaluation. 3 Units

Fundamental principles of pavement analysis, design, and evaluation. Topics include pavement materials, mechanics, traffic, and environmental loadings, pavement performance, design methods, and economic evaluation.

CE 299. Special Problems. 1 - 3 Units

Special problems in graduate research.
Note: Approval of a petition must be obtained from the faculty supervising the work and the Department Graduate Program Coordinator. Letter grade or Credit/No Credit.

Credit/No Credit

CE 500. Culminating Experience. 3 - 6 Units

Prerequisite(s): Advanced to candidacy and permission of the faculty advisor and Department Chair.
Successful completion of either: A. Thesis (3-6 units), or B. Project (3-6 units) or C. Directed Study and Examination (3 units). Plan A requires a thesis and is primarily research-orientated. Plan B requires a project report that is primarily application oriented. Plan C requires a detailed literature review or experimental data analysis resulting in a written report plus an examination by three faculty. A public presentation is required for all three plans.