

CIVIL ENGINEERING • CE

In the Department of Civil Engineering, the second digit of the course number denotes the subject area of the course, as follows: 0 (construction, excluding 8000, 9000); 1 (environmental); 2 (water resources); 3 (geotechnical); 4 (structures); 5 (surveying); 6 (transportation); 7 (general).

- 2200 Fluid Mechanics (3)** Prereq.: grade of "C" or better in CE 2450. Statics and dynamics of continuous liquids and gases; control volume laws; conservation of mass, momentum, and energy; dimensional analysis and similitude; applications to pipe flows.
- 2250 Fluid Mechanics Laboratory (1)** Prereq.: CE 2200 and CE 2720 (for CE majors, a grade of "C" or better is required in CE 2200). 3 hrs. lab. Measurement and calibration of hydraulic machinery; pump and turbine efficiency; flow in pipelines; viscosity; discharge coefficients.
- 2450 Statics (3)** Prereq.: grade of "C" or better in MATH 1550, 1552 and PHYS 2101. Vectorial treatment of resultants and equilibrium of force systems, centroids and centers of gravity, fluid statics, friction.
- 2460 Dynamics and Vibrations (3)** Prereq.: grade of "C" or better in CE 2450 and credit or registration in MATH 2065. Credit will not be given for this course and ME 3133. Treatment of kinematics and kinetics of particles and rigid bodies; force, movement, velocity, acceleration; impulse and momentum; work and energy; dynamics and vibration; concepts applied to structural and machine components.
- 2700 Introduction to Civil Engineering Practice (2)** Designed for civil engineering majors; open to nonmajors by consent of department. 1 hr. lecture; 3 hrs. lab. Credit will not be given for this course and EVEG 2000. Students will conduct three individual projects including civil engineering construction descriptions. Basic technical and professional aspects of civil engineering education and practice.
- 2720 Computational Methods in Civil and Environmental Engineering I (3)** Prereq.: MATH 1550 (for CE and EVEG majors, a grade of "C" or better is required in MATH 1550). Fundamental computational numerical and statistical techniques; descriptive statistics; correlation and regression analysis; numerical interpolation; root finding; and numerical integration and differentiation techniques for civil and environmental engineering systems.
- 3200 Hydraulics (3)** Prereq.: CE 2200 and 2720 (for CE and EVEG majors, a grade of "C" or better is required in CE 2200). Fundamentals of fluid mechanics applied to problems in the field of water; steady and unsteady flow in closed conduits, flow in open channels, measurement of flowing water, and turbo machinery; emphasis on computer methods.
- 3300 Geotechnical Engineering I (3)** Prereq.: GEOL 1001, CHEM 1202, CE 2200, and credit or registration in CE 3350 (for CE and EVEG majors, a grade of "C" or better is required in CHEM 1202 and CE 2200). Introduction to properties and engineering behavior of soil as a native earth material, an engineering material, and an environmental medium subject to flux and transport of liquids, gases, and contaminants; understanding of elementary physical, chemical, and biological phenomena as such phenomena influence the engineering behavior of soils.
- 3350 Geotechnical Engineering Laboratory I (1)** Prereq.: EXST 2201, and CE 2720 and credit or registration in CE 3300. 3 hrs. lab. Laboratory measurement of properties, indices, and behavior of soil as an engineering material and environmental medium; testing methods to determine gradation, specific shear strength testing, unconfined compression, one-dimensional consolidation, hydraulic conductivity, specific surface area, surface change, x-ray diffraction, pH-redox, and conductivity measurements.
- 3400 Mechanics of Materials (3)** Prereq.: Grade of "C" or better in CE 2450 and credit or registration in CE 2720 or equivalent. Stress and strain, torsion, bending, deflections of beams, columns, statically indeterminate problems, combined stress.
- 3410 Mechanics of Materials Laboratory (1)** Prereq.: EXST 2201 and CE 3400 (for CE majors a grade of "C" or better is required in CE 3400). 3 hrs. lab. Mechanical properties and strengths of engineering materials and structural and machine elements.
- 3415 Structural Analysis I (3)** Prereq.: MATH 2065 and CE 3400 (for CE majors, a grade of "C" or better is required in CE 3400). Analysis of statically determinate structures including beams, frames, trusses, and arches for the effects of dead, live, moving, and windloads.
- 3500 Plane Surveying and Measurements (3)** Prereq.: EXST 2201. 2 hrs. lecture; 3 hrs. lab. Plane surveying theory of measurements; use of surveying equipment; field and office work for boundary surveys and topographic mapping.
- 3600 Principles of Highway and Traffic Engineering (3)** Prereq.: CE 3500. Basic traffic characteristics; highway capacity analysis; geometric design of highways; route location, traffic operations, and signalized intersection design.
- 3700 Engineering Materials Laboratory (1)** Prereq.: credit or registration in CE 3400 or equivalent. 3 hrs. lab. Design and properties of concrete and bituminous mixes.
- 3740 Independent Studies in Civil Engineering (3)** Prereq.: senior standing, English proficiency, and ENGL 3002 (unless ROTC is elected); gpa of at least 2.30 (overall and major area); and consent of department chair. Project chosen in consultation with department chair. Formal proposal and final presentation required. Comprehensive design and/or development of a component, system, process, or software package.
- 4200 Hydrology (3)** Prereq.: CE 2200 (for CE and EVEG majors, a grade of "C" or better is required in CE 2200). Water movement from arrival on land surface until it reaches the sea overland; concept of frequency, maximum probable runoff of rainfall, mass curves, and other statistical methods of hydrologic engineering.
- 4250 Ground Water (3)** Prereq.: CE 2200 (for CE and EVEG majors, a grade of "C" or better is required in CE 2200). Occurrence of ground water; properties and classification of water-bearing formations; origin, discharge, and methods of evaluating direction and rate of ground water movement; Darcy's Law, Theis Equation, analysis of aquifer tests, and "safe yield;" legal doctrines, side effects of aquifer development, and the economics of ground water.
- 4260 Design of Hydrologic Systems (3)** Prereq.: CE 3200, 4200, and CE 4750 or equivalent. Hydrologic design of water resources projects; maximization of benefits; analysis techniques, and design parameters.
- 4300 Geotechnical Engineering II: Shallow Foundations (3)** Prereq.: CE 3300, 3350, and credit or registration in CE 4410. Fundamentals of geotechnics applied to design and analysis of shallow foundations, excavations, retaining structures, and slopes; selected topics on soil improvement and vibration; emphasis on computer utilization.
- 4310 Geotechnical Engineering III: Deep Foundations (3)** Prereq.: CE 3300 and 3350. Fundamentals of geotechnics applied to design and analysis of deep soil-structure systems; single piles and pile groups under axial load; caissons and piers; effects of lateral loads; computer utilization.
- 4320 Coastal Engineering (3)** Prereq.: CE 3300 or equivalent. Engineering problems of the coastal zone; coastal processes, wave action, currents, sediment movement; environmental forces due to waves, currents, and winds; offshore soil geotechnical properties, vertical and lateral pile capacity; design principles for submarine pipelines and offshore platforms; engineering case studies.
- 4400 Principles of Steel Design (3)** Prereq.: CE 3415. Analysis and design of elements of steel structures, elastic and plastic design, critical comparison of specifications with theory.
- 4410 Principles of Reinforced Concrete (3)** Prereq.: CE 3415. Working stress and ultimate strength theories as applied to concrete beams (reinforced and prestressed), columns, slabs, and footings; experimental data and current design specifications.
- 4420 Principles of Prestressed Concrete (3)** Prereq.: CE 4410. Analysis and design of prestressed concrete structural elements; full and partial prestressing; service ability and strength requirements; code criteria for bridges, buildings, and other structures.
- 4425 Principles of Wood Mechanics and Timber Design (3)** Prereq.: CE 3415 or equivalent. Basic principles of mechanics, elasticity, rheology, and failure as applied to wood; design methods and specifications governing the design of sawn lumber, plywood, and glulam timber structures and structural components.
- 4430 Structural Engineering (3)** Prereq.: CE 4750, 4400 and 4410, or equivalent. Fundamental principles applied to planning, analysis, and design of structures; introduction to computer-aided design approach to solving structural engineering problems using mainframe and microcomputer software.
- 4435 Indeterminate Structural Analysis (3)** Prereq.: CE 3415. Analysis of statically indeterminate structures; methods of consistent deformations, elastic energy, virtual work, slope deflection, moment distribution, and matrix formulations.
- 4440 Advanced Mechanics of Materials (3)** Prereq.: CE 3400 and MATH 2065 (for CE majors, a grade of "C" or better is required in CE 3400). Mechanics of materials; emphasis on needs of students interested in structural and machine design.
- 4445 Hurricane Engineering (3)** Prereq.: CE 3415 and CE 2200 or equivalent. Analysis and design of structures to resist hurricanes and other natural hazards; wind engineering, flood engineering; hazard phenomena and probabilities of occurrence; estimation of loads, loading provisions of major building codes and standards; damage mechanisms; design strategies for life safety and damage mitigation.
- 4450 Finite Element Methods (3)** Prereq.: CE 3400; and either MATH 2065 or 2090 or 2070 (for CE majors, a grade of "C" or better is required in CE 3400). Basic theory of finite element methods with applications to a wide class of physical problems; matrix representation of stress, strain, and material relations; principle of virtual work, discrete finite element models of continuous systems, construction of basic finite element algorithms, and solutions of physical problems by using existing finite element computer programs.
- 4460 Design of Bridges (3)** Prereq.: CE 4410, CE 4750, and credit or registration in CE 4400 or CE 4420, or equivalent. 2 hrs. lecture; 3 hrs. lab. Design of concrete and steel bridges in accordance with the latest AASHTO specifications; understanding of theoretical background behind the codes such as risk and reliability concepts; load rating of bridges, and hands-on bridge design using computer software and hand calculations.
- 4500 Geodetic and Photogrammetric Surveying (3)** Prereq.: CE 3500 or equivalent. 2 hrs. lecture; 3 hrs. lab. Geodetic surveying for control surveys; photogrammetry and photointerpretation; calculation and field procedures used in ground control surveys and photogrammetry.
- 4520 Advanced Surveying (3)** Prereq.: CE 3500 or equivalent. 2 hrs. lecture; 3 hrs. lab. Electronic surveying, simultaneous conveyances, subdivision surveys, flood plain management, state plane coordinates, solar azimuths, horizontal and vertical curves, and earthwork.
- 4530 Control Surveying with GPS (3)** Prereq.: CE 3500 or equivalent surveying course. 2 hrs. lecture; 3 hrs. lab. Understanding of spatial positioning capabilities available using satellite positioning system (GPS) receivers to calculate positions and to evaluate results; topics include classical geodetic methods, geometric geodesy, GPS receivers, static and kinematic GPS surveys, GPS computations, GPS mapping, vertical GPS, and gravimetric geodesy; lab includes demonstration and hands-on use of GPS equipment and software.

4550 Boundary Surveying (3) Prereq.: CE 3500 or equivalent. 2 hrs. lecture; 3 hrs. lab. Designed to prepare engineers to complete Land Surveyor Registration requirements in Louisiana. Procedures and laws governing surveying of boundaries; emphasis on U. S. Land Survey System and Louisiana surveying laws and grids.

4560 Engineering Applications of Remote Sensing (3) Prereq.: consent of instructor. 2 hrs. lecture; 3 hrs. lab. Photographic and digital image processes related to interpretation, principles, methods, and techniques; engineering applications in materials, land use, energy, hydrology, transportation, geology, geomorphology, and water resources.

4600 Geometric Design of Highways and Airports (3) Prereq.: CE 3600 or equivalent. 2 hrs. lecture; 3 hrs. lab. Principles of design and practice for rural and urban highway facilities and airport installations; design criteria and controls, capacity analysis, cross-section selection, design of horizontal and vertical alignment, intersections, interchanges and computer applications to design problems.

4620 Transportation Engineering (3) Prereq.: CE 3600 or equivalent. History, economics, and traffic characteristics of transportation systems; planning, design, construction, maintenance, and operation of air, highway, pipeline, rail, and water transportation facilities-vehicles, guideways, and terminals.

4650 Introduction to Asphalt Mixture Design (3) Prereq.: CE 3400 and credit or registration in CE 3700 (for CE majors, a grade of "C" or better is required in CE 3400). 3700 or equivalent. Principles of design and practice of hot mix asphalt mixture design; fundamental properties and analysis of binder rheology, aggregates, and mixture design.

4670 Fundamentals of Pavement Design (3) F Prereq.: CE 3600 or equivalent. Flexible and rigid pavement design procedures; subgrade, base, and surfacing characteristics; loads; stresses in pavement systems; material characterization; pavement response models; pavement performance models; structural design systems; effects of natural forces; and construction practices.

4730 Risk and Reliability Analysis in Civil and Environmental Engineering (3) Prereq.: CE 2720 and EXST 2201. Decision making under certainty; probability distributions and their characteristics relevant to civil and environmental engineering systems; data gathering and analysis; extraction of information; entropy theory; estimation of distribution parameters; error and uncertainty analysis; reliability analysis and estimation; risk analysis and estimation; model selection; and reliability-based civil and/or environmental engineering design.

4745 Natural Hazards and the Built Environment (3) Prereq.: junior standing. Credit will not be given for both this course and CE 4445. Engineering impacts and implications of hurricanes, floods, earthquakes, and other natural hazards on the built environment; effects of hazards on buildings and infrastructure systems; damage mechanisms; principles of wind, flood, and seismic resistant design; hurricane evacuation and sheltering; engineering preparedness, response and recovery issues; design strategies for life safety and damage mitigation; building codes, land use zoning, floodplain management, and insurance as mitigation tools.

4750 Professional Issues and Concept Design in Civil Engineering (2) Prereq.: CE 2700 and senior standing. 1 hr. lecture; 2 hrs. lab. Civil engineering design processes and systems; constructability and sustainability; use of consultants and contractors; project management, scheduling, economics and costing; ethical, health, and safety; social, political, and environmental considerations.

4760 Civil Engineering Design (3) Prereq.: credit in EVEG 3100, CE 3300, 3600, 4410 or equivalent, 4750, and credit in at least one of the following courses: CE 4200, 4300, 4400, 4600, or 4670. 2 hrs. lecture; 3 hrs. lab. Design of civil engineering facilities; feasibility studies for subdivisions, airports, shopping centers, interchanges.

4770 Professionalism and Ethical Practice of Civil Engineering (1) Prereq.: senior standing in civil engineering. Role of professionalism in engineering education and practice; the civil engineer's responsibility in preserving the environment and protecting the safety, health, and welfare of the public.

4780 Special Topics in Civil Engineering Science (3) Prereq.: senior standing and departmental approval. May be taken for a max. of 6 hrs. of credit. More than one section may be taken concurrently for credit if topics differ. Topics in specialized civil engineering technical or analysis areas.

4781 Special Topics in Civil Engineering Design (3) Prereq.: senior standing and departmental approval. May be taken for a maximum of 6 hrs. of credit when topics vary. More than one section of this course may be taken for credit concurrently when topics differ. Selected topics in civil engineering design.

7100 Theory and Operation of Wastewater Treatment Facilities (3) Prereq.: EVEG 3110; or equivalent undergraduate preparation, or consent of instructor. Theoretical principles, design criteria, and analysis of treatment systems for domestic and industrial wastewaters and sludges; includes modeling of ideal biochemical reactors and design criteria for suspended-growth and biofilm processes applicable to wastewater treatment.

7110 Operations and Processes in Sanitary Engineering II (3) Prereq.: EVEG 3100 and 3110; or equivalent undergraduate preparation. Theory and design of water and wastewater treatment processes.

7115 Water Quality Management (3) Current environmental engineering topics, with emphasis on water quality; governmental agencies, regulations, and technological limits affecting water and wastewater treatment, solid wastes, hazardous wastes, and air pollution.

7120 Sanitary Engineering Operations and Processes Lab (3) Prereq.: CE 4130, 7100, and credit or registration in CE 7110. 1 hr. lecture; 6 hrs. lab. Laboratory and pilot plant studies of water and wastewater treatment processes.

7135 Advanced Topics in Biodegradation (3) Biological waste treatment applications in civil and environmental engineering, including current and emerging techniques for characterization, analysis, control, and mathematical modeling of biological processes in municipal and industrial waste treatment systems.

7145 Biological Treatment of Recirculating Systems in Aquaculture (3) Theory, design, and management of fixed film biofiltration processes used to recondition water in recirculating aquaculture systems and to provide tertiary treatment of domestic and industrial wastes characterized by low substrate regimes.

7180 Water Quality Simulations (3) Prereq.: CE 4130. Water quality modeling from a perspective of practicality and reliability; emphasis on model calibration and verification procedures and methodologies for quantifying uncertainties associated with model predictions.

7255 Advanced Hydraulics (3) Prereq.: CE 2200. Transportation of sediment, mixing current, and other phenomena.

7265 Advanced Subsurface Hydrology and Hydraulics (3) Prereq.: CE 4250. Properties of porous media and fluid mixtures; dynamics of flow in single phase and multiphase flow systems; miscible and immiscible flow; basic concepts in saturated and unsaturated flow; solution procedures and applications in engineering design; physics and mathematics of transport processes in ground water; governing equations, solution procedures, and applications; waste management and pollution control in subsurface environments.

7270 Hydrologic Systems (3) Prereq.: CE 4200. Techniques of systems analysis and synthesis; application to hydrologic processes including runoff, stream flow routing, infiltration, evapotranspiration, and watershed yield; development of watershed models using these techniques and their application to engineering design.

7275 Modeling for Management of Groundwater (3) Prereq.: CE 4250. Identification of management problems; applications of systems theory to develop modeling techniques; analytical and numerical techniques of groundwater modeling; development and application of models and computer codes for simulation and optimization management of surface and groundwater systems.

7280 Modeling in Physical Hydrology (3) Prereq.: CE 4200. Principles of mathematical physics applied to hydrologic processes; methods of solution and model building; application to water resource problems.

7300 Advanced Geotechnical Engineering I: Stress Distribution, Seepage, Compressibility (3) Prereq.: CE 3300 and 3350. Advanced theories of soil mechanics including stress distribution, seepage through soils, consolidation, and settlement analysis; their applications in foundation engineering.

7305 Numerical Methods in Geotechnical Engineering (3) Prereq.: CE 4450. Numerical analysis of problems of seepage, consolidation, stress-deformation, slope stability, and wave equation for piles.

7310 Advanced Geotechnical Engineering II: Shear Strength, Bearing Capacity, Slope Stability (3) Prereq.: CE 7300. Shear strength of cohesive and cohesionless soils; stability problems including bearing capacity, slope stability, and earth pressure distribution.

7315 Principles of Soil Behavior (3) Prereq.: CE 3300, 3350. Analysis of the effect of compositional and environmental factors on conduction phenomena, volume change behavior, deformation, strength stress-strain-time behavior in soils; soil composition, mineralogy, soil-water electrolyte systems in identification of influencing variables.

7335 Soil Improvement and Stabilization (3) Prereq.: CE 4300. Methodology and analysis of soil placement and improvement techniques; properties of mineral and organic salts, principles of soil compaction; methods of soil placement and improvement, chemical stabilization of soils, lime columns, stone columns, ultimate strength and bearing capacity of columns, compression by surcharging and drains, dynamic consolidation, vibro stabilization, thermal properties of soils, thermal stabilization.

7340 Theory and Practice of Geotechnical Laboratory Experiments (3) Prereq.: CE 3300, 3350, and 4300; or equivalent. 2 hrs. lecture; 3 hrs. lab. Theory and practice of laboratory experimental techniques used in geotechnical design and analyses.

7345 In-Situ Soil Testing and Evaluation (3) Prereq.: CE 7340. Theory and practice of new and advanced geotechnical in-situ testing methods (I. e. piezo-cone penetrometer, self-boring pressure meter, dilatometer, etc.)

7350 Soil Dynamics and Introduction to Earthquake Engineering (3) Prereq.: CE 7310. Theory and practice related to soil-structure systems subject to time dependent loadings; wave propagation in various media, steady state and transient vibration of foundations, measurement of dynamic soil parameters, analysis and design procedures; influence of soils on ground motion characteristics; causes of soil failure during earthquakes; liquefaction.

7355 Environmental Geotechnics (3) Prereq.: CE 3300, 3350. Geotechnical aspects of waste management; solute transport in saturated media, flow in partially saturated media, diffusion in soil, sorption, hydraulic conductivity, soil-pore fluid interactions, compaction, clay and flexible membrane liners, slope stability/settlement considerations, remediation techniques.

7405 Statically Indeterminate Structures (3) Prereq.: CE 4435. Analysis of statically indeterminate structures by modern methods.

7409 Advanced Concrete Theory (3) Analysis and design of reinforced concrete structural elements according to ultimate strength and limit design theories; prestressed indeterminate structures, shrinkage, and creep.

7420 Limit Analysis and Design (3) Prereq.: credit or registration in CE 4435. Analysis of steel structural behavior beyond elastic limit; design for ultimate load and use of load factors; application of linear programming and other computational techniques to optimization of structures designed by aid of concepts of limit analysis.

7430 Structural Design for Dynamic Loads (3) Sources, intensities, and methods of transmission of dynamic loads; response of structural systems to dynamic loading; modern computation techniques.

7455 Finite Element Method in Engineering (3) Prereq.: CE 4450. Finite element method as an extended Ritz technique based on variational concepts for continua with applications to heat transfer, flow through porous media, fluid dynamics, elasticity, plasticity, and stability and vibrations of elastic systems.

7460 Theory of Plates (3) *Prereq.: credit or registration in CE 4440.* Laterally loaded plates with various boundary conditions; approximate methods of plate analysis; large deflections of plates; elastic stability of plates.

7470 Theory of Elastic and Plastic Stability (3) *Prereq.: credit or registration in 4435.* Beam columns, elastic and plastic buckling of bars and frames, torsional buckling, lateral buckling of beams, elastic and plastic stability of frames, plate and shell buckling, approximate and special methods, and high speed computation.

7475 Solid Mechanics (3) *Prereq.: CE 4440 and credit or registration in MATH 4038 or MATH 4340 or ME 4563.* Mathematical approach to statics and dynamics of deformable solids; tensors in curvilinear coordinates and variational calculus used to formulate elasticity and viscoelasticity theory; energy theorems and conservation laws.

7480 Plasticity and Viscoelasticity: Theory and Applications (3) *Prereq.: CE 4440.* Elements of the theory of plasticity; yield criteria and stress-strain relations for perfectly plastic and strain hardening materials; boundary value problems of plasticity; the slip-line theory and applications; constitutive equations of viscoelastic bodies and methods of solution of the boundary value problems of viscoelasticity.

7485 Mechanics of Composite Materials (3) *Prereq.: CE 3400.* Modeling of the mechanical behavior of fibrous composites for application to structural components; emphasis on interlaminar stresses, strength and failure theories, thermal effects, nonlinear material response, test methods, and micromechanics.

7490 Damage Mechanics in Metals and Matrix Composites (3) *Prereq.: CE 7480 and 7485 or equivalent.* Theoretical formulation and application of the different constitutive models to metals and metal matrix composites, but with consideration of other materials; analysis of isotropic and anisotropic damage in materials.

7500 Remote Sensing in Engineering Research (3) *Prereq.: CE 4560.* Physical measurements, characteristics of present and future sensors, and laboratory and field instrumentation; computer analysis of spectra data to include classification algorithms, enhancement, calibration, georeferencing, overlay, and data base development; image processing; environmental applications.

7600 Transportation Engineering Data Collection Methods (3) *Prereq.: EXST 7003, or CE 3600, or equivalent.* Applications of sampling theory to data collections for transportation studies; determination of sample sizes; calculation of sampling error; expansion of sample survey data; survey methodologies, including interviews, counting programs, moving observer surveys, self-administered surveys. Simple panel surveys, etc.; design of survey instruments; conduct of data collection activities; data reduction techniques.

7610 Traffic Engineering Operations and Control (3) F-O *Prereq.: CE 3600 or equivalent.* Traffic regulations, operational problems, and engineering organization; theory and practice of application, design, operation, and maintenance of traffic control devices; methods and devices studied include signing, markings, delineation and illumination, signals and signal systems, one-way street and unbalanced-flow street operations, speed zoning, and freeway monitoring and control.

7612 Traffic Flow and Analysis (3) S-O *Prereq.: CE 4600 or consent of instructor.* Traffic flow theory and the techniques used to analyze traffic operations and highway capacity; theoretical aspects of traffic flow, including current research in the field; application of analytical procedures used to assess the efficiency of highway operations.

7614 Intelligent Transportation Systems (3) V Theories and applications of Intelligent Transportation Systems (ITS).

7615 Advanced Highway Design and Traffic Safety (3) S-E *Prereq.: CE 4600 or consent of instructor.* Theoretical development and application of highway design principles, particularly as they relate to safety; analysis of accident statistics, diagnosis of high-hazard locations, risk management, tort liability, and design treatments to address high accident locations; design principles of traffic calming, highway-railroad grade crossings, highway work zones, and roadway cross-sections.

7621 Mass Transit Systems (3) *Prereq.: CE 3600 or equivalent.* Historical development, role in society, federal participation, and institutional and legislative development of transit; description of conventional and innovative forms, and characteristics of users; planning, vehicle scheduling, environmental impact and energy consumption; system costs, pricing and financing; future systems and policies.

7640 Urban Transportation Policy and Planning (3) *Prereq.: CE 3600 or equivalent.* Introduction to and definition of transportation planning; transportation planning context; characteristics of travel; politics, decision making and models of decision makers; systems analytic approaches to transportation planning; inventory, data management, and spatial representation of data; land use and transportation; inputs to travel forecasting.

7641 Urban Transportation Planning Models (4) S-E *Prereq.: CE 7640, ECON 5600, EXST 7003, or equivalent. 3 hrs. lecture; 2 hrs. lab.* Theories of travel demand modeling; conventional four-step modeling procedures; network development for highways, transit, high-occupancy vehicles; development of trip generation, distribution, and mode-choice models; highway and transit assignment procedures; use of current software for microcomputers.

7645 Transportation Systems Analysis (3) V *Prereq.: CE 7610 or equivalent.* Quantitative methods for analysis of transportation systems; basic network algorithms; macroscopic and microscopic traffic simulation models; dynamic traffic assignment approaches; network design problems with travel demand uncertainty; optimization concepts in transportation network modeling.

7650 Bituminous Materials and Mixtures (3) S-O *Prereq.: CE 3700 or equivalent. 2 hrs. lecture; 3 hrs. lab.* Properties of asphalts and tars used in bituminous materials; historical developments; properties and design of bituminous mixtures; theory and practice of asphalt concrete mix design for pavements and bases including specification and construction methods for hot-mixes and surface treatments.

7652 Transportation Engineering - Materials (3) *Prereq.: CE 4670 or equivalent.* Earthen materials fills and subgrades; aggregates types, properties, and performance; introduction to asphalt and asphaltic concrete; introduction to cement and cement concrete; variability, OC Curves; stabilization principles and practices; unsealed roads.

7655 Pavement Materials Characterization (4) F-O *Prereq.: CE 3700 or equivalent. 3 hrs. lecture; 3 hrs. lab.* Laboratory and field test methods for determining engineering properties of pavement materials; interpretation of test data for selecting property values; use of fundamental engineering properties in design and analysis of pavement response to environmental and vehicular loads.

7672 Pavement Management Systems (3) S-O *Prereq.: CE 3600 or equivalent.* Concepts of pavement, evaluation of pavement performance, serviceability concepts, structural evaluation, safety, maintenance and rehabilitation, economic considerations, selection of alternatives, and life cycle cost analysis.

7673 Pavement Maintenance and Rehabilitation (3) S-E *Prereq.: CE 3700 or equivalent.* Concepts of pavement maintenance and rehabilitation; pavement evaluation techniques; maintenance versus rehabilitation versus replacement alternatives.

7700, 7701 Special Topics in Civil Engineering (3,3) *Prereq.: permission of department. Each course may be taken for a max. of 6 hrs. of credit.* Specialized civil engineering areas.

7740 Master's Report (3) *Comprehensive report with oral defense on subject approved by the major professor.*

7750 Seminar (1) *All graduate students are expected to enroll every semester. Only one semester hour of credit will be allowed toward degree. Pass-fail grading.*

8000 Thesis Research (1-12 per sem.) "S" or "U" grading.

9000 Dissertation Research (1-12 per sem.) "S" or "U" grading.