Civil and Environmental Engineering (ENGRCEE)

Courses

ENGRCEE 11. Methods II: Probability and Statistics. 4 Units.
Modeling and analysis of engineering problems under uncertainty. Engineering applications of probability and statistical concepts and methods.
Prerequisite: (ENGRCEE 20 or EECS 10 or EECS 12 or ENGRMAE 10 or I&C SCI 31) and MATH 3A.
Restrictions: Civil Engineering majors and Environmental Engineering majors have the first consideration for enrollment.

ENGRCEE 15. Introduction to Energy Systems. 4 Units.
Introduces technological, economic, environmental, social, and political aspects behind power systems' design, planning, operations, and maintenance. Changes to demand and supply for electricity, climate change risks to power systems, and equity dimensions.
(II or III)

ENGRCEE 20. Introduction to Computational Problem Solving. 4 Units.
Introduction to computer programming within a numerical computing environment (MATLAB or similar) including types of data representation, graphical display of data, and development of modular programs with application to engineering analysis and problem solving.
Corequisite: MATH 3A.
Overlaps with BME 60B.
Restrictions: Civil Engineering majors and Environmental Engineering majors have the first consideration for enrollment.

ENGRCEE 21. Computational Problem Solving. 4 Units.
Engineering analysis and problem solving using MATLAB (or similar), including matrix algebra, solving systems of linear and nonlinear equations, numerical integration of ordinary differential equations (ODEs) and coupled ODEs, and analysis of numerical errors.
Corequisite: MATH 3D.
Prerequisite: (ENGRCEE 20 or BME 60B) and (MATH 3A or I&C SCI 6N).
Restrictions: Civil Engineering majors and Environmental Engineering majors have the first consideration for enrollment.

ENGRCEE 30. Statics. 4 Units.
Addition and resolution of forces, distributed forces, equivalent system of forces centroids, first moments, moments and products on inertia, equilibrium of rigid bodies, trusses, beams, cables.
Corequisite: MATH 2D.
Prerequisite: MATH 2D and PHYSICS 7C.
Same as ENGR 30, ENGRMAE 30
Restrictions: School of Engineering students have the first consideration for enrollment.

ENGRCEE 40. Fundamentals of Economic Analysis for Scientists and Engineers. 4 Units.
Introduction to microeconomics and cost benefit analysis. Integration of economic, social, and behavioral considerations into the engineering design process. Applications to contemporary problems via case studies.
(III)

ENGRCEE 50. Infrastructure Equity. 4 Units.
The intersection of social justice with the built and natural environment through theories of equity and justice to analyze transportation, housing, water systems, energy service disparities in historically marginalized and underserved communities of color in California.
(VII)

ENGRCEE 60. Contemporary and Emerging Environmental Challenges. 4 Units.
Introduces contemporary and emerging environmental challenges, illustrates links between human behavior, environmental policy, and engineering practices, examines policy options in the context of current institutions, and introduces tools and frameworks to reach sound economic, social, and environmental solutions.
(III)

ENGRCEE 80. Dynamics. 4 Units.
Introduction to the kinematics and dynamics of particles and rigid bodies. The Newton-Euler, Work/Energy, and Impulse/Momentum methods are explored for ascertaining the dynamics of particles and rigid bodies. An engineering design problem using these fundamental principles is also undertaken.
Prerequisite: MATH 2D and PHYSICS 7C.
Same as ENGR 80, ENGRMAE 80
Restrictions: Mechanical Engineering majors, Aerospace Engineering majors, Civil Engineering majors, Materials Science and Engineering majors, and Environmental Engineering majors have the first consideration for enrollment.

ENGRCEE 81A. Civil Engineering Practicum I. 3 Units.
Introduction to civil engineering through presentations on structural, environmental, water, and transportation systems. Introduction to graphics. Graphical visualization and communication using hand and computer sketching. Fundamentals of Computer Aided Design (CAD) using AutoCad. Laboratory sessions. Materials Fee
Restrictions: Civil Engineering majors and Environmental Engineering majors have the first consideration for enrollment.

ENGRCEE 81B. Civil Engineering Practicum II. 3 Units.
Principles of surveying; fundamentals of Geographic Information Systems (GIS); introduction to the state-of-the-art and future areas of the profession, including applications of advanced technology and computers; Introduction to visualization and communication of design concepts; laboratory sessions. Materials Fee
Restrictions: Civil Engineering majors and Environmental Engineering majors have the first consideration for enrollment.

ENGRCEE 110. Methods III: Modeling, Economics, and Management. 4 Units.
Analysis, modeling, and management of civil engineering systems. Statistics and system performance studies, probabilistic models and simulation, basic economics and capital investments, project elements and organization, managerial concepts and network technique, project scheduling. Emphasis on real-world examples. Laboratory sessions.
Prerequisite: ENGRCEE 11.
Restrictions: Civil Engineering majors and Environmental Engineering majors have the first consideration for enrollment.

ENGRCEE 111. Methods IV: Systems Analysis and Decision-Making. 4 Units.
Analysis and optimization for decision-making in civil and infrastructural systems. Topics include linear programming formulations and solution algorithms, network models, and logistical models. Emphasis is on project-level and managerial decision-making and selection from alternative designs.
Prerequisite: (MATH 3A or I&C SCI 6N) and MATH 3D.
Restrictions: Civil Engineering majors have the first consideration for enrollment.

ENGRCEE 114. GIS for Civil and Environmental Engineering. 4 Units.
GIS for CEE provides an introduction to Geographic Information Systems (GIS) and their various applications in civil and environmental engineering. Topics include GIS data formats, data queries, spatial and attribute data, spatial data analysis, coordinate systems, and raster data analysis.
Concurrent: ENGRCEE 214

ENGRCEE 121. Transportation Systems I: Analysis and Design. 4 Units.
Introduction to analysis and design of fundamental transportation system components, basic elements of geometric and pavement design, vehicle flow and elementary traffic, basic foundations of transportation planning and forecasting. Laboratory sessions.
Prerequisite: ENGRCEE 11 and ENGRCEE 81A.
Restrictions: Civil Engineering majors have the first consideration for enrollment.

ENGRCEE 122. Transportation Systems II: Operations and Control. 4 Units.
Introduction to fundamentals of urban traffic engineering, including data collection, analysis, and design. Traffic engineering studies, traffic flow theory, traffic control devices, traffic signals, capacity and level of service analysis of freeways and urban streets. Laboratory sessions.
Prerequisite: ENGRCEE 11 and ENGRCEE 121.
Restrictions: Civil Engineering majors have the first consideration for enrollment.
Concurrent: ENGRCEE 229A

ENGRCEE 123. Transportation Systems III: Planning and Forecasting. 4 Units.
Theoretical foundations of transportation planning, design, and analysis methods. Theory and application of aggregate and disaggregate models for land use development, trip generation, destination, mode, and route choice. Transportation network analysis. Planning, design, and evaluation of system alternatives.
Corequisite: ENGRCEE 110.
Prerequisite: ENGRCEE 121.
Restrictions: Civil Engineering majors have the first consideration for enrollment.
Concurrent: ENGRCEE 223

ENGRCEE 124. Transportation Systems IV: Freeway Operations and Control. 4 Units.
Fundamentals of traffic on urban freeways, including data collection analysis, and design. Traffic engineering studies, traffic flow theory, freeway traffic control devices, capacity, and level of service analysis of freeways and highways. Laboratory sessions.
Prerequisite: ENGRCEE 121.
Restrictions: Civil Engineering majors have the first consideration for enrollment.

ENGRCEE 125. Transportation and the Environment. 4 Units.
Analysis of the impacts of motor vehicle transportation on the environment. Introduction to life cycle analysis applied to transportation. Basic economic tools for transportation externalities. Transportation planning, urban form, health, and the environment. Transportation sustainability.
Restrictions: Civil Engineering majors have the first consideration for enrollment.

ENGRCEE 130. Soil Mechanics. 4 Units.
Mechanics of soils, composition and classification of soils, compaction, compressibility and consolidation, shear strength, seepage, bearing capacity, lateral earth pressure, retaining walls, piles.
Corequisite: ENGRCEE 130L.
Prerequisite: ENGRCEE 150 and ENGRCEE 170.
Restrictions: Civil Engineering majors and Environmental Engineering majors have the first consideration for enrollment.

ENGRCEE 130L. Soil Mechanics Laboratory. 1 Unit.
Laboratory procedures of soil testing for engineering problems. Materials Fee
Corequisite: ENGRCEE 130.
Restrictions: Civil Engineering majors and Environmental Engineering majors have the first consideration for enrollment.

ENGRCEE 149. Introduction to Earthquake Engineering. 4 Units.
Nature of earthquakes, hazard analyses, structural dynamics for earthquake engineering, seismic design force determination methods: ELF, modal response spectrum, nonlinear time history analyses. Diaphragm analyses, redundancy, nonlinear response, ductile systems, hysteretic behavior. Basics of seismic design for steel, timber, concrete.
Prerequisite: ENGRCEE 11 and (ENGRCEE 20 or BME 60B) and ENGRCEE 151A.
Restrictions: Civil Engineering majors have the first consideration for enrollment.
Concurrent: ENGRCEE 249

ENGRCEE 150. Mechanics of Materials. 4 Units.
Stresses and strains, strain-stress diagrams, axial deformations, torsion, bending and shear stresses in beams, shear force and bending moment diagrams, combined stresses, principal stresses, Mohr's circle, deflection of beams, columns.
Prerequisite: ENGRCEE 30 with a minimum grade of C- or ENGRMAE 30 with a minimum grade of C- or ENGR 30 with a minimum grade of C-.
Overlaps with ENGR 150, ENGRMAE 150.
Restrictions: Civil Engineering majors and Environmental Engineering majors have the first consideration for enrollment.

ENGRCEE 150L. Mechanics of Materials Laboratory. 1 Unit.
Experimental methods and fundamentals for mechanics of materials analysis. Materials Fee
Corequisite: ENGRCEE 150.
Prerequisite: (ENGRCEE 30 with a minimum grade of C- or ENGRMAE 30 with a minimum grade of C- or ENGR 30 with a minimum grade of C-) and ENGRCEE 150.
Overlaps with ENGRMAE 150L.
Restrictions: Civil Engineering majors and Environmental Engineering majors have the first consideration for enrollment.

ENGRCEE 151A. Structural Analysis. 4 Units.
Fundamentals of structural analysis and loading. Deformation of statically determinate and indeterminate structures. Influence lines. Structural systems.
Prerequisite: ENGRCEE 150 or ENGRMAE 150.
Restrictions: Civil Engineering majors have the first consideration for enrollment.

ENGRCEE 151B. Structural Timber Design. 4 Units.
Design of timber structures. Beams, columns, beam-columns, roof, and connections.
Prerequisite: ENGRCEE 151A.
Restrictions: Civil Engineering majors have the first consideration for enrollment.

ENGRCEE 151C. Reinforced Concrete Design. 4 Units.
Ultimate strength design. Design of reinforced concrete beam sections. Design for shear and deflection. Design of columns. Design of isolated and combined footings. Laboratory sessions. Materials Fee
Prerequisite: ENGRCEE 151A.
Restrictions: Civil Engineering majors have the first consideration for enrollment.

ENGRCEE 152. Computer Methods in Structural Analysis and Design. 4 Units.
Matrix techniques for indeterminate framed structures. Computer implementation using the stiffness method. Software packages for design of reinforced concrete, steel, and/or timber structures.
Prerequisite: ENGRCEE 151C.
Restrictions: Civil Engineering majors have the first consideration for enrollment.

ENGRCEE 155. Structural Steel Design. 4 Units.
Design in steel of tension members, beams, columns, welded and bolted connections; eccentrically loaded and moment resistant joints; plate girders. Plastic design; load and resistance factor design. Composite construction; introduction to computer-aided design.
Prerequisite: ENGRCEE 151A.
Restrictions: Civil Engineering majors have the first consideration for enrollment.

ENGRCEE 156. Foundation Design. 4 Units.
Applications of soil mechanics principles to the analysis and design of shallow foundations, retaining walls, pile foundations, and braced cuts. Design criteria: bearing capacity, working loads and tolerable settlements, structural integrity of the foundation element. Damage from construction operations.
Prerequisite: ENGRCEE 130 and ENGRCEE 151C.
Restrictions: Civil Engineering majors have the first consideration for enrollment.

ENGRCEE 160. Environmental Processes. 4 Units.
Introduction to environmental processes in air and water, mass balances, and transport phenomena. Fundamentals of water-quality engineering including water and wastewater treatment.
Prerequisite: (CHEM 1B or CHEM H2B) and ENGRCEE 170.
Restrictions: Civil Engineering majors, Chemical Engineering majors, and Environmental Engineering majors have the first consideration for enrollment.

ENGRCEE 162. Introduction to Environmental Chemistry. 4 Units.
Basic concepts from general, physical, and analytical chemistry as they relate to environmental engineering. Particular emphasis on the fundamentals of equilibrium and kinetics as they apply to acid-base chemistry, gas solubility, and redox reactions. Laboratory sessions. Materials Fee
Prerequisite: (ENGR 1A or CHEM 1A or CHEM H2A) and (CHEM 1B or CHEM H2B) and (CHEM 1LC or CHEM 1LE or CHEM H2LB or CHEM M2LB) and (CHEM 51A or CHEM H52A).
Restrictions: Chemical Engineering majors and Environmental Engineering majors have the first consideration for enrollment.

ENGRCEE 163. Wastewater Treatment Process Design. 4 Units.
Design of biological treatment processes. Topics include attached and suspended growth, aeration, anaerobic systems, process control, and economics. Design projects included. Materials Fee
Prerequisite: ENGRCEE 160.
Restrictions: Civil Engineering majors, Chemical Engineering majors, and Environmental Engineering majors have the first consideration for enrollment.

ENGRCEE 164. Carbon and Energy Footprint Analysis. 4 Units.
Process design for wastewater treatment. Mass- and energy-balance analysis applied to water and wastewater treatment systems. Case studies include analysis of water supply, treatment, reclamation, and reuse.
Prerequisite: ENGRCEE 163 or ENGRCEE 165.
Restrictions: Civil Engineering majors and Environmental Engineering majors have the first consideration for enrollment.
Concurrent: ENGRCEE 264

ENGRCEE 165. Physical-Chemical Treatment Processes. 4 Units.
Theory and dynamics of physical and chemical separation processes in water and wastewater treatment. Topics include coagulation, sedimentation, filtration, gas-transfer, membrane separations, and adsorption.
Prerequisite: ENGRCEE 160 and (ENGRMAE 91 or CBE 40C).
Restrictions: Civil Engineering majors and Environmental Engineering majors have the first consideration for enrollment.
Concurrent: ENGRCEE 265

ENGRCEE 166. Microbial Processes for Bioremediation. 4 Units.
Fundamental knowledge on microbiology, organic chemistry, biodegradability and persistence, reaction kinetics, and contaminant transport of water and soil remediation of organic contaminants under aerobic and anaerobic conditions. Overview of Environmental Law and Superfund. Design project of bioremediation for contaminated site.
Restrictions: Civil Engineering majors and Environmental Engineering majors have the first consideration for enrollment.
Concurrent: ENGRCEE 206P

ENGRCEE 168. Microorganisms and Climate Change. 4 Units.
Climate change and impacts on microbial processes: greenhouse gas generation, biogeochemical cycles, permafrost thawing, ocean acidification, eutrophication, pathogen proliferation. Microorganism-based solutions that can mitigate climate change impacts (microbial greenhouse control, production of lower carbon and energy footprint goods, carbon sequestration).

ENGRCEE 169. Environmental Microbiology for Engineers. 4 Units.
Fundamental and applied principles of microbiology. Structures and functions of microorganisms, the microbiology of water, wastewater and soil used in environmental engineering, and the impact of microorganisms on human and environmental health.
Prerequisite: ENGRCEE 160.
Restrictions: Civil Engineering majors and Environmental Engineering majors have the first consideration for enrollment.

ENGRCEE 170. Introduction to Fluid Mechanics. 4 Units.
Thermodynamic and mechanical fluid properties; fluid statics; control volume and differential approaches for mass, momentum, and energy; dimensional analysis and similarity.
Corequisite: MATH 2E, ENGRCEE 20.
Prerequisite: PHYSICS 7C.
Restrictions: Civil Engineering majors and Environmental Engineering majors have the first consideration for enrollment.

ENGRCEE 171. Water Resources Engineering. 4 Units.
Principles governing the analysis and design of water resource systems including pressurized pipelines, pipe networks, channels, and ground water. Coverage of fluid mass, momentum and energy conservation, flow resistance, and related laboratory measurements in different systems. Materials Fee
Prerequisite: ENGRCEE 170.
Restrictions: Chemical Engineering majors, Civil Engineering majors, and Environmental Engineering majors have the first consideration for enrollment.

ENGRCEE 172. Groundwater Hydrology. 4 Units.
Topics include conservation of fluid mass, storage properties of porous media, matrix compressibility, boundary conditions, flow nets, well hydraulics, groundwater chemistry, and solute transport. Design projects and computer applications included.
Prerequisite: ENGRCEE 170 or ENGRMAE 130A or CBE 120A.
Restrictions: Civil Engineering majors, Chemical Engineering majors, and Environmental Engineering majors have the first consideration for enrollment.

Concurrent: ENGRCEE 272

ENGRCEE 173. Watershed Modeling. 4 Units.
Basic principles of hydrologic modeling are practiced. Concepts of watershed delineation, land use change impact, design studies, and GIS tools are discussed. Focus on the USACE (HEC) software tools (HEC-HMS, and HEC-RAS) along with their associated GIS interfaces.
Prerequisite: ENGRCEE 170 and ENGRCEE 176.
Restrictions: Civil Engineering majors and Environmental Engineering majors have the first consideration for enrollment.
Concurrent: ENGRCEE 273

ENGRCEE 176. Hydrology. 4 Units.
Elements of the hydrologic cycle including precipitation, infiltration, evapotranspiration, ground water, and runoff. Unit Hydrograph theory and routing methods. Introduction to precipitation/runoff relationship and watershed modeling. Statistical methods and flood frequency analysis.
Prerequisite: ENGRCEE 170 or ENGRMAE 130A.
Restrictions: Civil Engineering majors and Environmental Engineering majors have the first consideration for enrollment.
Concurrent: ENGRCEE 276

ENGRCEE 178. Fluid Mechanics of Open Channels. 4 Units.
Fundamentals of fluid motion in open channels. Navier-Stokes equations and one-dimensional momentum and energy principles. Topics include rapidly varied flow, flow resistance and turbulence, gradually varied flow, unsteady flow, and computational methods for channel flow modeling.
Prerequisite: (ENGRCEE 20 or BME 60B or ENGRMAE 10) and (ENGRCEE 170 or ENGRMAE 130A or CBE 120A).
Restrictions: Civil Engineering majors and Environmental Engineering majors have the first consideration for enrollment.

ENGRCEE 181A. Senior Design Practicum I. 2 Units.
Team designs land development project including infrastructural, environmental, circulation aspects. Focus on traffic impact studies, design of roads, geometry, signals, geotechnical and hydrological analysis, design of structural elements, economic analysis. Oral/Written interim and final design reports. Laboratory sessions.
Prerequisite: ENGRCEE 81A and ENGRCEE 81B and ENGRCEE 110 and (ENGRCEE 121 or ENGRCEE 151C or ENGRCEE 162 or ENGRCEE 171). ENGRCEE 181A and ENGRCEE 181B and ENGRCEE 181C must be taken in the same academic year.
Restrictions: Seniors, Civil Engineering majors, and Environmental Engineering majors only.

ENGRCEE 181B. Senior Design Practicum II. 2 Units.
Team designs land development project including infrastructural, environmental, circulation aspects. Focus on traffic impact studies, design of roads, geometry, signals, geotechnical and hydrological analysis, design of structural elements, economic analysis. Oral/Written interim and final design reports. Laboratory sessions.
Corequisite: ENGRCEE 130.
Prerequisite: ENGRCEE 181A. ENGRCEE 181A and ENGRCEE 181B and ENGRCEE 181C must be taken in the same academic year.
Restrictions: Seniors, Civil Engineering majors, and Environmental Engineering majors only.

ENGRCEE 181C. Senior Design Practicum III. 2 Units.
Team designs land development project including infrastructural, environmental, circulation aspects. Focus on traffic impact studies, design of roads, geometry, signals, geotechnical and hydrological analysis, design of structural elements, economic analysis. Oral/Written interim and final design reports. Laboratory sessions.
Prerequisite: ENGRCEE 181B. ENGRCEE 181A and ENGRCEE 181B and ENGRCEE 181C must be taken in the same academic year.
Restrictions: Seniors, Civil Engineering majors, and Environmental Engineering majors only.

ENGRCEE 195. Special Topics in Civil and Environmental Engineering. 1-4 Units.
Studies in selected areas of Civil and Environmental Engineering. Topics addressed vary each quarter.
Prerequisite: Prerequisites vary.
Repeatability: May be taken unlimited times as topics vary

ENGRCEE 197. Civil and Environmental Engineering Internship. 2-12 Units.
Students majoring in CEE may receive credit for an approved internship, working at a company under the supervision of an industry mentor and a faculty advisor. Enables students to gain valuable experience in a professional setting and enhance their skills.
Grading Option: Pass/Not Pass only
Repeatability: May be taken for credit 3 times

ENGRCEE 198. Group Study. 1-4 Units.
Group study of selected topics in Civil and Environmental Engineering.
Repeatability: May be taken unlimited times

ENGRCEE 199. Individual Study. 1-4 Units.
For undergraduate Engineering majors in supervised but independent reading, research, or design. Students taking individual study for design credit are to submit a written paper to the instructor and to the Undergraduate Student Affairs Office in the School of Engineering.
Repeatability: May be taken for credit for 8 units

ENGRCEE 199P. Individual Study. 1-4 Units.
Supervised independent reading, research, or design for undergraduate Engineering majors. Students taking individual study for design credit are to submit a written paper to the instructor and to the Undergraduate Student Affairs Office in the School of Engineering.
Grading Option: Pass/Not Pass only
Repeatability: May be taken unlimited times

ENGRCEE 201P. Life Cycle Assessment Methods. 4 Units.
Introduction and application of life cycle assessment methods for characterizing resource consumption and environmental emissions of products and civil infrastructure systems. Life cycle inventory development, system boundaries and scoping, calculation of environmental impact indicators.
Restrictions: Master of Engineering only.

ENGRCEE 202P. Green Building Design. 4 Units.
Application of life cycle assessment methods to green and sustainable building design. Overview and application of building sustainability rating and certification systems using the LEED framework. Assessment and comparison of different building types.
Restrictions: Master of Engineering only.

ENGRCEE 203P. Organizational Pollutant Emissions Accounting. 4 Units.
Application of life cycle assessment methods to account for emissions from the supply chain of products and infrastructure systems. Calculation and proper interpretation of Scope 1, 2, and 3 emissions categories and emissions footprint metrics.
Restrictions: Master of Engineering only.

ENGRCEE 204P. Fundamentals of Sustainable Engineering. 4 Units.
Introduction to sustainability and its connection to environmental engineering infrastructure: economic/social sustainability, lifecycle assessment/cost, water and waste management, empathy in engineering, quantitative approaches for social sustainability, and decision-making across sustainability metrics. Includes guest lectures and field trips.
Restrictions: Master of Engineering only.

ENGRCEE 205P. Wastewater Treatment Process Design. 4 Units.
Process design for wastewater treatment. Topics include solids separation, biological treatment, aeration, sludge stabilization, process control, and economics. Design projects included.
Restrictions: Master of Engineering only.
Concurrent: ENGRCEE 163

ENGRCEE 206P. Biological Processes for Bioremediation. 4 Units.
Fundamental knowledge on microbiology, organic chemistry, biodegradability and persistence, reaction kinetics, and for development of water and soil remediation of organic contaminants under aerobic and anaerobic conditions. Overview of Environmental Law and Superfund.
Restrictions: Master of Engineering only.
Concurrent: ENGRCEE 166

ENGRCEE 207P. Introduction to Data Science Programming and Optimization. 4 Units.
Basics of object-oriented programming; data analysis using scientific programming packages; best programming practices; civil and environmental engineering analysis and design of linear systems; introduction to the analysis and design of non-linear systems in civil engineering.
Restrictions: Master of Engineering only.

ENGRCEE 208P. Data Analytics for Civil Engineers. 4 Units.
Quantitative research methods and statistical techniques for analyzing and viewing civil and environmental engineering data. Descriptive statistics, hypothesis testing, linear and logical regression, clustering and introduction to machine learning.

ENGRCEE 209P. Applied Sustainability Topics in Civil and Environmental Engineering Practice. 4 Units.
Case studies guiding project-based assignments for applying sustainability fundamentals, pollution and life-cycle cost analyses, and green building design principles to real-world problems in civil and environmental engineering.
Restrictions: M.Engr. - Civil and Environmental Engineering majors only.

ENGRCEE 210P. Smart City Transport Systems. 4 Units.
Focuses on engineering methods and concepts associated with smart cities and applies these methods and concepts to analyze emerging and future transportation technologies, services, and systems.
Restrictions: Master of Engineering only.

ENGRCEE 211P. Sustainable Transportation. 4 Units.
Overview of the impacts of transportation on the environment, with an emphasis on air pollution from motor vehicles, but including broader impacts such as regional air quality, noise, human health, water and solid waste pollution, land use, and climate change.
Restrictions: Master of Engineering only.

ENGRCEE 212P. Transportation Policy and Technology. 4 Units.
The process of planning, designing, and managing the transportation system from the perspective of current and emerging transportation policies and technologies. Focus on technical and institutional perspectives on issues.
Restrictions: Master of Engineering only.

ENGRCEE 213P. Air Pollution Science and Control. 4 Units.
Concepts related to sources, dispersion, and effects of air pollutants. Topics include emission factors, emission inventory, air pollution, meteorology, air chemistry, air quality modeling, impact assessment, source and ambient monitoring, regional control strategies.

ENGRCEE 214. GIS for Civil and Environmental Engineering. 4 Units.
GIS for CEE provides an introduction to Geographic Information Systems (GIS) and their various applications in civil and environmental engineering. Topics include GIS data formats, data queries, spatial and attribute data, spatial data analysis, coordinate systems, raster data analysis.
Concurrent: ENGRCEE 114

ENGRCEE 215P. Environmental Permitting and Impact Reporting. 4 Units.
Regulatory frameworks, CEQA, NEPA. Environmental documents: Initial Studies, EIRs, EAs. Mitigation measures, legal challenges. Case studies, project-based exercises, industry guest lectures. Emphasis on practical applications, real-world environmental reviews, compliance, and permitting processes.

ENGRCEE 220A. Travel Demand Analysis I. 4 Units.
Fundamentals of transportation systems analysis. Theoretical aspects of travel demand. Travel behavior. Modeling of performance characteristics and costs of transportation modes. In-depth presentation of travel demand modeling techniques. Development of travel choice models including mode, route, and destination choice. Equilibrium.

ENGRCEE 220B. Travel Demand Analysis II. 4 Units.
Methods of discrete choice analysis and their applications in the modeling of transportation systems. Emphasis on the development of a sound understanding of theoretical aspects of discrete choice modeling that are useful in many applications in travel demand analysis.
Prerequisite: ENGRCEE 220A with a minimum grade of B-.

ENGRCEE 220C. Travel Demand Analysis III: Activity-based Approaches. 4 Units.
The methodological underpinnings of activity-based travel demand modeling. Presents methodologies within the context of a generalization of discrete choice modeling approaches, emphasizing the distinctions that separtate these two approaches and presenting appropriate mathematical and statistical tools to address these distinctions.
Prerequisite: ENGRCEE 220A with a minimum grade of B-.

ENGRCEE 221A. Transportation Systems Analysis I. 4 Units.
Introduction to mathematical methods and models to address logistics and urban transportation problems. Techniques include stochastic models, queueing theory, linear programming, and introductory non-linear optimization.

ENGRCEE 221B. Transportation Systems Analysis II. 4 Units.
Advanced mathematical methods and models to address logistics and urban transportation problems. Topics include network flows, advanced optimization techniques, network models, and heuristic algorithms.
Prerequisite: ENGRCEE 221A with a minimum grade of B-.

ENGRCEE 221C. Transportation Systems Analysis III: Stochastic Simulation for Design of Mobility and Logistics Services. 4 Units.
Fundamentals and applied methods for simulating stochastic and stochastic-dynamic transportation systems. Topics include uncertainty modeling of inputs, discrete-event simulation, programming simulation logic in Python, generating random variates, analyzing simulation outputs, experimental design, model verification and validation.

ENGRCEE 222. Transit Systems Planning. 4 Units.
Planning methods for public transportation in urban areas. Technological and operating characteristics of vehicles, facilities, and systems. Short-range planning techniques: data collection and analysis, demand analysis, mode choice, operational strategies, financial analysis. Design of systems to improve performance.

ENGRCEE 223. Transportation Systems III: Planning and Forecasting. 4 Units.
Theoretical foundations of transportation planning, design, and analysis methods. Theory and application of aggregate and disaggregate models for land use development, trip generation, destination, mode, and route choice. Transportation network analysis. Planning, design, and evaluation of system alternatives.
Concurrent: ENGRCEE 123

ENGRCEE 224A. Transportation Data Analysis I. 4 Units.
Statistical analysis of transportation data sources. Analysis of categorical and ordinal data. Regression and advanced multivariate analysis methods such as discriminant analysis, canonical correlation, and factor analysis. Sampling techniques, sample error and bias, survey instrument design.

ENGRCEE 224B. Transportation Data Analysis II. 4 Units.
Advanced statistical models and their applications in civil and environmental engineering. Topics include spatial statistics, spatial econometrics, structural equation modeling, and discrete choice modeling (including hybrid choice models).
Prerequisite: ENGRCEE 224A with a minimum grade of B-.

ENGRCEE 226A. Traffic Flow Theory I. 4 Units.
Traffic measurement and fundamental speed-density-flow relationships. Kinematic models. Shock waves. Statistical-kinetic theory of traffic. Introductory car-following principles and stability. Gap acceptance. Platoon dispersion. Two-fluid model. Queueing process. Multi-regime and catastrophe models. Higher-order continuum models. Microscopic and macroscopic simulation.

ENGRCEE 226B. Traffic Flow Theory II. 4 Units.
Advanced mathematical analysis of vehicular flow. Detailed treatise on car-following models. Fourier and Laplace analysis of stability problems. Perturbation analysis. Derivation of macroscopic traffic flow relationships from microscopic considerations. Advanced hydrodynamic theory.
Prerequisite: ENGRCEE 226A with a minimum grade of B-.

ENGRCEE 228A. Urban Transportation Networks I. 4 Units.
Analytical approaches and algorithms to the formulation and solution of the equilibrium assignment problem for transportation networks. Emphasis on user equilibrium (UE) comparison with system optimal, mathematical programming formulation, supply functions, estimation. Estimating origin-destination matrices, network design problems.
Prerequisite: ENGRCEE 220A with a minimum grade of B-.

ENGRCEE 228B. Urban Transportation Networks II. 4 Units.
Advanced analysis, optimization, and modeling of transportation networks. Topics include advanced static and dynamic traffic assignment algorithms, linear and nonlinear multi-commodity network flow optimization, network simplex, and network control problems.
Prerequisite: ENGRCEE 221A with a minimum grade of B- and ENGRCEE 228A with a minimum grade of B-.

ENGRCEE 229A. Traffic Systems Operations and Control I. 4 Units.
Introduction to operation, control, and analysis of arterial and freeway traffic systems. Control concepts, traffic stream principles, detectors, local controllers, system masters, traffic signal and ramp metering timing principles, traffic measurement technologies, traffic delay principles.
Concurrent: ENGRCEE 122

ENGRCEE 229B. Traffic Systems Operations and Control II. 4 Units.
Advanced topics related to operation, control, and analysis of arterial and freeway traffic systems. Control concepts, traffic stream principles, detectors, local controllers, system masters, traffic signal and ramp metering timing principles.
Prerequisite: ENGRCEE 229A with a minimum grade of B-.

ENGRCEE 231. Foundation Engineering. 4 Units.
Essentials for design and analysis of structural members that transmit superstructure loads to the ground. Topics include subsurface investigations, excavation, dewatering, bracing, footing, mat foundations, piles and pile foundations, caissons and cofferdams, other special foundations.

ENGRCEE 231P. Foundation Engineering. 4 Units.
Essentials for design and analysis of structural members that transmit superstructure loads to the ground. Topics include subsurface investigations, excavation, dewatering, bracing, footing, mat foundations, piles and pile foundations, caissons and cofferdams, other special foundations.
Restrictions: Master of Engineering only.

ENGRCEE 232. Geotech Earthquake Engineering. 4 Units. 0 Workload Units.
In-situ and laboratory determination of dynamic soil properties, liquefaction of soil, cyclic softening of clays, seismic compression and settlement analyses, ground improvement methods, seismic slope stability, introduction to soil structure interaction.

ENGRCEE 234P. Adv Structural Modeling with Commercial Software. 4 Units.
Nonlinear analysis fundamentals, pushover and time history analysis, material and component cyclic modeling and validation. Damping considerations, practical modeling challenges. Applied use of commercial software for nonlinear structural modeling.

ENGRCEE 235P. Applied Structural Seismic Design and Evaluation. 4 Units.
Contemporary and emerging structural design/assessment methods, performance-based seismic design, hazard analysis, engineering response assessment, prediction of collapse, damage and loss modeling. Project involving performance assessment of multistory buildings.
Restrictions: M.Engr. - Civil and Environmental Engineering majors only.

ENGRCEE 236P. Practical Soil-Structure Interaction for Infrastructure. 4 Units.
Principles and applications of soil-structure interaction in foundation and structural design. Topics include seismic effects, numerical modeling, superstructure implications, and case studies. Hands-on use of industry software to simulate and evaluate real-world geo-structural systems.

ENGRCEE 237P. Building Information Modeling and Structural Design Management. 4 Units.
Understanding integration of Building Information Modeling (BIM) into structural design workflows. Focus on project coordination, collaboration with other contractors, and effective management of design data to streamline construction processes and ensure project success including plan reading and interpretation.

ENGRCEE 240. High Performance Materials. 4 Units.
Part I: Linear and nonlinear fracture mechanics, methodology, real-world case studies; Part II: Composite material toughening, underlying micromechanics, materials engineering towards microstructure tailoring and new material design approaches; Part III: Emerging high-performance engineering materials for safety, energy and the environment.

ENGRCEE 242. Advanced Strength of Materials. 4 Units.
Beams on elastic foundations. Combined axial and lateral loads. Curved beams. Unsymmetric bending. Shear center. Stresses and strains. Basic equations for theory of elasticity. Energy principles. Theory of torsion. Combined bending and torsion.

ENGRCEE 247. Structural Dynamics. 4 Units.
Vibration of discrete and continuous mass elastic systems. Isolation and transmissability. Dynamic recording instruments. Introduction to nonlinear theory of vibration. Response of structures to earthquake, traffic, and wind loads. Response spectra concepts. Normal mode analysis. Numerical integration techniques.

ENGRCEE 247P. Structural Dynamics. 4 Units.
Dynamic equilibrium of structures. Response of a single degree of freedom system to dynamic excitation: free vibration, harmonic loads, pulses, and earthquakes. Response spectra. Response of multi-degree of freedom systems. Seismic behavior of buildings and the basis of seismic building.
Restrictions: Master of Engineering only.

ENGRCEE 249. Earthquake Engineering. 4 Units.
Nature of earthquakes, hazard analyses, structural dynamics for earthquake engineering, seismic design force determination methods: ELF, modal response spectrum, nonlinear time history analyses. Diaphragm analyses, redundancy, nonlinear response, ductile systems, hysteretic behavior. Basics of seismic design for steel, timber, concrete.
Concurrent: ENGRCEE 149

ENGRCEE 250. Finite Element Method in Structural Engineering. 4 Units.
Finite element concepts in structural engineering including variational formulations, shape functions, elements assembly, convergence and computer programming. Stiffness of truss, beam, and frame members, two- and three-dimensional solids, plate and shell elements. Static, vibration, stability, and inelastic analysis.

ENGRCEE 250P. Finite Element Method in Structural Engineering. 4 Units.
Finite element concepts in structural engineering including mathematical/variational formulations, shape functions, elements assembly, convergence, and computer programming; stiffness of truss, beam, and frame members; and two- and three-dimensional solids.
Restrictions: Master of Engineering only.

ENGRCEE 251. Performance-Based Structural Engineering. 4 Units.
Introduction and implementation of current approaches in performance-based assessment and design of building structures. Emphasis is on applied and evolving methods and tools for exercising performance-based engineering of building structures.
Prerequisite: ENGRCEE 247 with a minimum grade of B- and ENGRCEE 249 with a minimum grade of B-.

ENGRCEE 252. Multiscale Modeling of Materials and Structures. 4 Units.
Introduction to modeling materials and structures across length and time scales. Emphasis is on fundamental concepts, numerical simulation techniques, and algorithms for exercising multiscale modeling from nano to meso and microscale.

ENGRCEE 253. Micromechanics. 4 Units.
Micromechanics concepts in solid mechanics including eigenstrains, Eshelby equivalent inclusion theories, homogenization procedures, Mori-Tanaka method, self-consistent scheme, and effective mechanical behavior of composites.

ENGRCEE 254. Advanced Reinforced Concrete Behavior and Design. 4 Units.
Flexural strength of reinforced concrete elements. Flexural ductility of unconfined and confined members with axial loads. Shear and torsional behaviors. Strength of reinforced concrete ductile frames and shear walls. Reinforced concrete detailing.

ENGRCEE 254P. Advanced Reinforced Concrete Behavior and Design. 4 Units.
Centers on advanced concepts in the design of reinforced concrete structures, encompassing areas such as two-way slabs, flat plates, slender columns, member ductility, special moment frames, shear walls, and incorporating sustainability considerations.
Prerequisite: Knowledge of reinforced concrete design and introduction to earthquake engineering.
Restrictions: Master of Engineering only.

ENGRCEE 255. Advanced Behavior and Design of Steel Structures. 4 Units.
Advanced principles of structural steel design. Analysis and design of beam-column members, braced and unbraced frames for buildings, and plate girders. Review of seismic design provisions. Design of connections.

ENGRCEE 255P. Advanced Structural Steel Design. 4 Units.
Advanced principles of structural steel design with special coverage on the sustainability of structural steel as a building material. Technical coverage in the analysis and design of beam-column members, braced and unbraced frames for buildings, and plate girders.
Prerequisite: Knowledge of structural design engineering and seismic design provisions.
Restrictions: Master of Engineering only.

ENGRCEE 258. Earthquake Resistant Structural Design. 4 Units.
Objectives of seismic design. Cyclic load-distortion characteristics of typical structural elements. Desirable structural form. Ductility and methods of achieving it. Use of energy dissipators. Project involving design of multistory, multibay rigid-jointed plane frame.

ENGRCEE 260. Desalination. 4 Units.
Introduction of state of technology, costs and benefits, environmental issues, and implementation issues related to desalination. Emphasis on membrane processes and biofouling prevention.

ENGRCEE 262. Environmental Chemistry II. 4 Units.
Advanced concepts from physical and organic chemistry as they relate to environmental engineering. Emphasis on equilibrium and kinetics as they apply to redox reactions, coordination, absorption, gas phase reactions, and ion exchange.

ENGRCEE 263. Advanced Biological Treatment Processes. 4 Units.
Analysis of biological processes in natural and engineered systems. Biological treatment processes, both aerobic and anaerobic, with emphasis on suspended growth systems including design consideration. Containment degradation or control covered. Includes laboratory on molecular tools used in wastewater treatment.

ENGRCEE 264. Carbon and Energy Footprint Analysis. 4 Units.
Process design for wastewater treatment. Mass- and energy- balance analysis applied to water and wastewater treatment systems. Case studies include analysis of water supply, treatment, reclamation, and reuse.
Concurrent: ENGRCEE 164

ENGRCEE 264P. Carbon and Energy Footprint Analysis. 4 Units.
Process design for wastewater treatment. Mass- and energy- balance analysis applied to water and wastewater treatment systems. Case studies include analysis of water supply, treatment, reclamation, and reuse.
Prerequisite: Undergraduate-level introduction to environmental processes, mass balances, and transport phenomena.
Restrictions: Master of Engineering only.

ENGRCEE 265. Physical-Chemical Treatment Processes. 4 Units.
Theory and dynamics of physical and chemical separation processes in water and wastewater treatment. Topics include coagulation, sedimentation, filtration, gas transfer, membrane separations, and absorption.
Concurrent: ENGRCEE 165

ENGRCEE 266P. Biological Process Design. 4 Units.
Applied microbiology and engineering principles to understand and solve important environmental problems in water quality. Focus on biological processes within both engineered and natural systems, and utilizes fundamental stoichiometry, kinetics, and material balances to analyze and quantify microbial processes.
Restrictions: Master of Engineering only.

ENGRCEE 267. The Science and Engineering of Wildfires. 4 Units.
Covers the fundamental science of wildfire behavior, scales, modeling techniques, and emerging engineering solutions to mitigate wildfire risks.
Prerequisite: Recommended: ENGRCEE 11 and ENGRCEE 110.
Concurrent: ENGRCEE 167

ENGRCEE 268. Environmental Fluid Mechanics and Turbulence. 4 Units.
Covers the nonlinear physics of turbulence flows with a focus on environmental applications.

ENGRCEE 269. Beach Dynamics. 4 Units.
Coastal erosion in California, human and natural influences on southern California beaches, and present-day challenges. Littoral cells and sediment budgets. Water wave theory. Littoral sediment transport and shoreline change modeling. Shoreline stabilization using green and gray infrastructure.

ENGRCEE 269P. Beach Dynamics. 4 Units.
Provides an introduction to the processes that influence coastal erosion and morphological change and the broader factors that must be considered to implement projects such as project financing, coastal protection. Includes field trips to beaches in southern California.
Restrictions: Master of Engineering only.

ENGRCEE 270. Flood Risk and Modeling. 4 Units.
Global and national trends in flooding and related impacts including disasters; flood risk management; theory and numerical methods for flood inundation modeling; flood risk communication strategies including flood hazard visualizations.

ENGRCEE 270P. Flood Risk and Modeling. 4 Units.
Introduction to flood risk management, including coverage of the consequences and causes of flooding, trends in flooding, how flood risk is managed, and modeling methods for supporting various aspects of flood management.
Restrictions: Master of Engineering only.

ENGRCEE 271. Flow in Unsaturated Porous Media. 4 Units.
Fluid flow in the unsaturated zone (zone of aeration) of the subsurface. Soil-water physics, flow in regional groundwater systems, miscible displacement, mathematical modeling techniques.

ENGRCEE 272. Groundwater Hydrology. 4 Units.
Topics include conservation of fluid mass, storage properties or porous media, matrix compressibility, boundary conditions, flow nets, well hydraulics, groundwater chemistry, and solute transport. Includes introduction to advanced topics in porous media. Design projects and computer applications included.
Concurrent: ENGRCEE 172

ENGRCEE 273. Watershed Modeling. 4 Units.
Basic principles of hydrologic modeling are practiced. Concepts of watershed delineation, land use change impact, design studies, and GIS tools are discussed. Focus on the USACE (HEC) software tools (HEC-HMS and HEC-RAS) along with their associated GIS interfaces.
Concurrent: ENGRCEE 173

ENGRCEE 274. Climate Data Analysis. 4 Units.
Trend analysis; statistical indices for diagnosing and detecting changes in extremes; nonstationary processes; extreme value analysis; multivariate extreme value methods; tail dependence estimation; uncertainties in observed and projected changes in climate extremes.

ENGRCEE 275. Stochastic Hydrology. 4 Units.
Statistical analysis and modeling of hydrologic and geophysical data for decision making, frequency analysis of extreme precipitation and floods for hydrologic design, time series analysis for hydrological simulation, spectral analysis, and geostatistical analysis of spatially correlated fields.

ENGRCEE 276. Hydrology. 4 Units.
Elements of the hydrologic cycle including precipitation, infiltration, evapotranspiration, ground water, and runoff. Unit Hydrograph theory and routing methods. Introduction to precipitation/runoff relationship and watershed modeling. Statistical methods and flood frequency analysis. Discussion section covers advanced topics.
Concurrent: ENGRCEE 176

ENGRCEE 279. Environmental Transport Modeling. 4 Units.
Computational modeling of multi-dimensional flow and scalar transport problems in surface and ground water. Topics include mathematical model formulation, numerical method selection, serial and parallel implementation, model verification and validation.

ENGRCEE 281. Structural Reliability. 4 Units.
Applications of probability theory to reliability analysis of engineering structures. Theory of structural reliability. Estimation of static random loads. Reliability analysis of structural components and system. Monte Carlo simulation.

ENGRCEE 283. Mathematical Methods in Engineering Analysis. 4 Units.
Matrices; vector calculus; eigenvalue problems; Fourier analysis; partial differential equations; special functions; numerical analysis; finite difference method.

ENGRCEE 289. Analysis of Hydrologic Systems. 4 Units.
Application of systems theory in hydrologic, land surface, biogeochemical modeling. Design, identification, and calibration of conceptual models. Principles of dynamic systems, modeling approaches, theory of linear systems, mathematical concepts of differential calculus, theoretical concepts of parameter estimation and optimization theory.

ENGRCEE 290A. Machine, Model, and Statistical Learning I. 4 Units.
Introduction to machine, model, and statistical learning, featuring a series of topics on how to leverage data for model development ("learning"), model calibration ("training"), model evaluation ("verification"), and uncertainty quantification, illustrated using simple practice exercises and real-world case studies.
Prerequisite: Recommended: Foundational skills in Mathematics, Statistics, and MATLAB.

ENGRCEE 290B. Machine, Model, and Statistical Learning II. 4 Units.
Advanced mathematical concepts in machine, model, and statistical learning. Linear algebra, information, probability, and set theory. Topics include sensitivity analysis, forecast verification, model selection, model averaging, data assimilation (Kalman filter), and sequential Monte Carlo (particle filter).
Prerequisite: ENGRCEE 290A with a minimum grade of B-.

ENGRCEE 291. Hydrologic Remote Sensing. 4 Units.
Introduction to principles of remote sensing and application in hydrology. Review of sensor systems, thermal and multispectral image processing, and image classification. Examples from remote sensing of hydrologic processes such as precipitation, soil moisture, and vegetation are covered.
Prerequisite: ENGRCEE 276 with a minimum grade of B-.

ENGRCEE 292. Wavelets in Hydrology, Engineering, and Geoscience. 4 Units.
Multiscale analysis of hydrologic, engineering, and earth system processes; energy decomposition in the time-frequency domain via wavelets; applications to fluid flows, climate and mechanical signals for feature extraction, trend analysis, coherent structures, and upscaling/downscaling.

ENGRCEE 295. Seminars in Engineering. 1-4 Units.
Seminars scheduled each year by individual faculty in major field of interest.
Grading Option: Satisfactory/Unsatisfactory only
Repeatability: May be taken unlimited times as topics vary

ENGRCEE 295P. Special Topics in Civil and Environmental Engineering. 4 Units.
Studies in selected areas of Civil and Environmental Engineering. Topics addressed vary each quarter.
Repeatability: May be taken 1 time as topics vary
Restrictions: Master of Engineering only.

ENGRCEE 296. Master of Science Thesis Research. 1-16 Units.
Individual research or investigation conducted in preparation of the thesis required for the M.S. degree in Engineering.
Grading Option: Satisfactory/Unsatisfactory only
Repeatability: May be taken unlimited times

ENGRCEE 297. Doctor of Philosophy Dissertation Research. 1-16 Units.
Individual research or investigation conducted in preparation for the dissertation required for the Ph.D. degree in Engineering.
Grading Option: Satisfactory/Unsatisfactory only
Repeatability: May be taken unlimited times

ENGRCEE 298. Special Topics in Civil and Environmental Engineering. 1-4 Units.
Presentation of advanced topics and special research areas in civil and environmental engineering.
Repeatability: May be taken unlimited times as topics vary

ENGRCEE 299. Individual Research. 1-16 Units.
Individual research or investigation under the direction of an individual faculty member.
Grading Option: Satisfactory/Unsatisfactory only
Repeatability: May be taken unlimited times