CIVIL AND ENVIRONMENTAL ENGINEERING

Department Website (https://www.sc.edu/study/colleges_schools/engineering_and_computing/departments/civil_and_environmental_engineering/)

Dr. Juan Caicedo, Chair

Civil and environmental engineers are involved with the systems that are essential to our modern way of life. For example, civil and environmental engineers plan, design, and construct roads, bridges and airports, buildings, water supply and wastewater treatment plants, waterways, ports, and dams. They also work to protect the environment by developing and applying remedial technologies to contaminated groundwater and soil. Civil and environmental engineers are well qualified to participate in public and private decision-making processes regarding infrastructure systems, and, as such, serve as technical and policy advisors or elected officials.

The Department of Civil and Environmental Engineering offers programs leading to the Master of Science, Master of Engineering, and Doctor of Philosophy degrees. Students in the M.S. and Ph.D. degree programs specialize in at least one of the following program areas: environmental engineering, geotechnical engineering, structural engineering, transportation engineering, water resources engineering and railway engineering. Students in the M.E. program may opt to specialize in one area of study or obtain a broad range of experience across the civil and environmental engineering discipline.

Areas of Specialization

Environmental Engineering focuses on sustainability and environmental applications and implications of nanotechnology, including water and wastewater reclamation, bioreactor landfills, waste conversion processes, treatment technologies for developing countries, application of nanomaterials for developing innovative remediation technologies, quantum modeling of nanomaterials, and understanding fate, transport, and toxicity of nanomaterials in the environment.

Geotechnical Engineering focuses on soil, rock and engineered geomaterials with specific concentrations on field and laboratory investigations using standard and novel testing technologies, design and performance of foundations and earth structures, slope stability analyses, soil dynamics and liquefaction, pavement design and performance, landfill design and instrumentation, and geoenvironmental studies.

Structural Engineering focuses on structural design, and analysis for buildings, bridges and other civil structures, materials characterization and modeling including concrete, steel and fiber reinforced polymers, multi-scale structural testing, advanced numerical simulations, structural health monitoring and prognosis, life-cycle and environmental performance analysis, and seismic engineering and design.

Transportation Engineering focuses on modeling transportation system operations, traffic sensing technologies and traffic data analyses, including intelligent transportation systems, modeling and simulation of large-scale transportation networks, weigh-in-motion systems, traffic studies, traffic signal simulation and pavement management systems and performance modeling.

Water Resources Engineering focuses on the study and computer modeling of natural and industrial flow and transport processes, both in the laboratory and in the field, including fluid mechanics, hydraulic transients, cardiovascular flow, river mechanics and marine sediment transport, scour, hydrology of landfills, storm water modeling and best management practices, and watershed scale hydrology.

Railway Engineering focuses on the unique challenges of planning, design, monitoring, inspection, maintenance and management of railway infrastructure and operations of the freight and passenger railway network through development and implementation of novel technologies, intelligent systems, remote sensing, field and laboratory testing procedures, and advanced computer modeling and simulations.

Accelerated B.S.E./Master's Plans

A combined B.S./M.S. or B.S./M.E. degree program is available to undergraduate civil and environmental engineering students with GPAs of 3.40 or above and 90 or more hours earned toward their B.S. degree. Up to six (6) credit hours at or above the 500-level may be applied toward a student's B.S./M.E. program of study. Up to a total of six (6) credit hours of ECIV 797 and graduate course work at or above the 500-level toward a B.S. degree may be applied toward a student's B.S./M.S. program of study. The approval of the student's advisor and the Department's graduate director are required. Questions about this program may be directed to the Department's graduate director.

Programs

- Civil Engineering, M.E. (https://academicbulletins.sc.edu/graduate/engineering-computing/civil-environmental-engineering/civil-engineering-me/)
- Civil Engineering, M.S. (https://academicbulletins.sc.edu/graduate/engineering-computing/civil-environmental-engineering/civil-engineering-ms/)
- Civil Engineering, Ph.D. (https://academicbulletins.sc.edu/graduate/engineering-computing/civil-environmental-engineering/civil-engineering-phd/)
- Railway Engineering, Certificate (https://academicbulletins.sc.edu/graduate/engineering-computing/civil-environmental-engineering/railway-engineering-certificate/)

Courses

ECIV 502 - Life Cycle Assessment of Engineered Systems (3 Credits)
The steps of conducting and interpreting an environmental life cycle assessment of engineered systems. Fundamentals associated with conducting a life cycle assessment, including goal and scope, inventory analysis, impact assessment and interpretation.
Prerequisites: D or better in ECIV 350.

ECIV 503 - Structural Modeling and Experimental Methods (3 Credits)
Introduction of structural modeling; strain gauge instrumentation; force, displacement, acceleration, pressure, temperature measurements; concrete and steel modeling; size effects; analysis of experimental data.
Prerequisites: ECIV 327.

ECIV 520 - Structural Analysis II (3 Credits)
Advanced methods of structural analysis with emphasis on matrix methods. Development of the generalized matrix force and matrix displacement methods of static analysis, with applications to trusses and frames.
Prerequisites: D or better in ECIV 320.

ECIV 521 - Numerical Methods in Mechanics (3 Credits)
Numerical modeling of typical engineering problems. Numerical solution of linear and nonlinear, boundary and initial value problems. Introduction to optimization.
Prerequisites: D or better in ECIV 201 or ENCP 201.

ECIV 524 - Structural Vibrations (3 Credits)
Response of single- and multiple-degree of freedom structurally dynamic systems to impact, harmonic, wind, and seismic excitations.
Prerequisites: D or better in ECIV 320.

ECIV 526 - Timber and Masonry Design (3 Credits)
Basic engineering properties of timber and masonry materials, design methods and philosophies for timber and masonry structures. Particular attention is paid to current codes, specifications and analysis.
Prerequisites: C or better in ECIV 320.

ECIV 530 - Foundation Analysis and Design (3 Credits)
Subsurface investigation procedures. Theoretical and practical aspects of the design of earth retaining structures, spread footings, and pile foundations.
Prerequisites: D or better in ECIV 330.

ECIV 531 - Design of Earth Structures (3 Credits)
Geotechnical engineering problems associated with the behavior of earth masses. Soil shear strength, lateral earth pressure, design of retaining structures, slope stability, water flow through soils.
Prerequisites: ECIV 330.

ECIV 533 - Geosynthetics and Geotechnical Design of Landfills (3 Credits)
Principles for the design, construction, and performance of waste containment systems. Characterization of barrier materials; geosynthetics; design of liner and leachate collection systems; stability and deformation analyses of landfills.
Prerequisites: D or better in ECIV 330.

ECIV 535 - Geotechnical Engineering in Transportation (3 Credits)
Remote sensing and engineering geology. Field and laboratory testing. Design and maintenance methods for flexible and rigid pavements. Topics in tunnel design and buried conduit.
Prerequisites: D or better in ECIV 330.

ECIV 539 - Experimental Methods in Geotechnical Engineering (3 Credits)
Overview of transducers, signal conditioning and data acquisition; test control methods, data analysis and measurement errors; testing systems to measure soil strength, stiffness, and hydraulic conductivity; laboratory projects and examinations.
Prerequisites: ECIV 330, ECIV 330L.

ECIV 540 - Transportation Systems Planning (3 Credits)
Fundamental interactions between supply and demand in transportation systems. Modeling transportation demand and trip-making behavior. Evaluation of alternatives for decision making.
Prerequisites: D or better in ECIV 340.

ECIV 541 - Highway Design (3 Credits)
Design of transportation facilities using relevant tools and guidelines with emphasis on physical and operational aspects of arterials, freeways, intersections, and interchanges, including geometry, capacity, control, and safety.
Prerequisites: D or better in ECIV 111 or ENCP 102 and D or better in ECIV 340.

ECIV 542 - Traffic Engineering (3 Credits)
Capacity analysis of freeways and arterials. Traffic flow characteristics and basic relationships among traffic flow parameters. Signalized and unsignalized intersection control and signal timing design.
Prerequisites: D or better in ECIV 340.

ECIV 543 - Traffic Safety Analysis (3 Credits)
Research concepts and methodologies to enable students to identify the underlying reasons and factors that contribute to traffic crashes and determine appropriate countermeasures.
Prerequisites: D or better in ECIV 340.

ECIV 551 - Elements of Water and Wastewater Treatment (3 Credits)
Unit operations and processes employed in the physical, chemical, and biological treatment of water and wastewater. Design of water and wastewater treatment systems.
Prerequisites: ECIV 350.

ECIV 555 - Principles of Municipal Solid Waste Engineering (3 Credits)
Fundamentals and engineering principles of solid waste generation, characterization, collection and transport, source reduction and recycling, and physical, chemical, and biological treatment strategies.
Prerequisites: D or better in ECIV 350.

ECIV 556 - Air Pollution Control Engineering (3 Credits)
Introduction to the sources of air pollution and the engineering principles used for control and prevention.
Prerequisites: D or better in ECIV 350.

ECIV 557 - Sustainable Construction for Engineers (3 Credits)
Instruction to sustainable engineering design alternatives and principles for construction and site development from preconstruction through design and the construction phase.
Prerequisites: D or better in ECIV 350 and ECIV 570.

ECIV 558 - Environmental Engineering Process Modeling (3 Credits)
Modeling fate and transport phenomena in environmental processes with applications in engineered unit operators and natural systems.
Prerequisites: D or better ECIV 350 and MATH 242.

ECIV 560 - Open Channel Hydraulics (3 Credits)
Steady and unsteady flows in single or multiple-channel systems.
Prerequisites: D or better in ECIV 360 or ENCP 360.

ECIV 562 - Engineering Hydrology (3 Credits)
Applications of hydrologic techniques to design problems; stormwater simulation models; urban stormwater.
Prerequisite or Corequisite: D or better in ECIV 362.

ECIV 563 - Subsurface Hydrology (3 Credits)
Hydrologic cycle, subsurface physical properties, equations of groundwater flow, well flow, well design, groundwater resource development, design of dewatering systems, groundwater contamination.
Prerequisites: D or better in ECIV 201 or ENCP 201; D or better in ECIV 362.

ECIV 570 - Land Development for Engineers (3 Credits)
Fundamentals of designing and permitting the conversion of land to new or altered states, including environmental issues, traffic and parking, utility resources, site engineering, ADA, safety, planning, and zoning requirements.
Prerequisites: Three from ECIV 320, ECIV 330, ECIV 340, ECIV 350, and ECIV 362.

ECIV 580 - Railway Engineering I (3 Credits)
Introduction to the analysis and design of the railway infrastructure for freight and passenger systems to include track and track support systems, grade crossings, special trackwork, construction, inspection, assessment and compliance.
Prerequisites: D or better in ECIV 320, ECIV 330, and ECIV 340.

Prerequisite or Corequisite: D or better in ECIV 303.

ECIV 582 - Operation and Logistics of Railway Systems (3 Credits)
Principles of rail operations; Network management; Best practices for train planning, performance management and delivery of service; technical elements of a railway from an operations perspective (train controls, signaling, communications, yards, tractive power etc).
Prerequisites: D or better in ECIV 340.

ECIV 588 - Design of Railway Bridges and Structures (3 Credits)
Introduction to railway infrastructure; Structural design considerations and criteria of railway structures; Bridge types and components; Planning and preliminary design of modern railway bridges; Loads and forces; Structural analysis and design of steel railway bridges and components.
Prerequisite or Corequisite: D or better in ECIV 330; D or better in ECIV 325 or ECIV 327.

ECIV 590 - Intermediate Special Topics (3 Credits)
The content of this course varies, and the topics are selected by the faculty. The aim of this course is to expose upper-level undergraduate students and graduate students to a contemporary issue, not covered in any Civil and Environmental Engineering course. Possible topics include intelligent infrastructure, sustainable construction, and monitoring and improvement of poor and degrading infrastructure.

ECIV 705 - Deterministic Civil and Environmental Systems Engineering (3 Credits)
Planning, design, and operation of large-scale, integrated civil and environmental engineering systems, with applications of mathematical programming and other search models.
Prerequisites: ECIV 405.

ECIV 706 - Probabilistic Civil and Environmental Systems Engineering (3 Credits)
Civil and environmental systems engineering under uncertainty, including decision rules, decision theory, uncertainty propagation, stochastic programming, and conservative design.
Prerequisites: STAT 509.

ECIV 707 - Management of Engineering Projects (3 Credits)
This course focuses in studying the life-cycle of a project using a systems engineering approach. Industry standards for engineering companies as well as practical considerations are studies through the semester.

ECIV 708 - Engineering Risk and Reliability (3 Credits)
Risk analysis is presented in the context of reliability in design including applications to mechanical and electrical systems with discussion of failure modes and life cycle costs.

ECIV 712 - Boundary Element Methods in Engineering (3 Credits)
Introduction to boundary element methods and their computer implementation. Steady-state and transient solutions of two- and three-dimensional problems of elasticity and potential flow.
Prerequisites: ENCP 260, MATH 242.

ECIV 720 - Advanced Structural Mechanics and Analysis (3 Credits)
Development of concepts and practical applications of the finite element method of structural analysis with emphasis on the displacement method approach. Initial strains, specified displacements, numerical integration, and isoparametric elements are included.
Prerequisites: ECIV 520.

ECIV 722 - Theory and Design of Plates and Shells (3 Credits)
Development of the fundamental differential equations for plates. Miscellaneous classic plate solutions. Membrane and bending solutions for shells of revolution, circular cylindrical shells, hyperbolic paraboloid shells and circular cylindrical barrel shells.
Prerequisites: MATH 242.

ECIV 724 - Dynamics of Structures (3 Credits)
Lumped and continuous multidegree of freedom mechanical systems and structural assemblies. Steady-state, shock, and random excitation. Modal analysis, numerical methods. Introduction to wave propagation, earthquake engineering, and nonlinear vibrations.
Prerequisites: ENCP 260, MATH 242.

ECIV 725 - Advanced Analysis and Design in Structural Metals (3 Credits)
Analysis and behavior of metal structural components under general loading combinations. Buckling phenomena of thin-walled open sections in the elastic and inelastic regions, and correlation with design code criteria. Behavior and design of plate girders.
Prerequisites: ECIV 325.

ECIV 726 - Repair and Retrofit of Structures (3 Credits)
Analysis and modeling existing and repaired structures. Selection, modeling, and design of repair and/or retrofit measures.
Prerequisites: ECIV 520.

ECIV 727 - Advanced Analysis and Design of Reinforced Concrete (3 Credits)
Design of multistory structures, two-way slabs, joints in buildings, pavement design, and miscellaneous topics.
Prerequisites: ECIV 327.

ECIV 728 - Prestressed Concrete Analysis and Design (3 Credits)
Pre-stressing methods and materials; flexural analysis, shear and torsion, design of simple, composite and continuous beams. Deflections, slab design, and study of axially loaded members.
Prerequisites: ECIV 327.

ECIV 730 - Advanced Soil Mechanics (3 Credits)
Course covers the mechanical properties of soil; analysis of the field and laboratory tests to determine soil properties required for foundation analysis and design; consolidation theory; and settlement analysis.
Prerequisites: ECIV 530.

ECIV 731 - Slope Stabilty, Retaining Systems and Lateral Earth Pressure (3 Credits)
Shear strength of soil and rock under effective stress. Slope stability analysis, tieback and reinforced earth systems. Computation of earth pressures for excavations and tunnels. Dewatering for construction.
Prerequisites: ECIV 530.

ECIV 732 - Theoretical and Numerical Methods in Geomechanics (3 Credits)
Constitutive models and their numerical implementation. Elastic and plastic approaches to analysis. Finite element applications to geomechanics problems. Layer analysis, arching, and stability case studies.
Prerequisites: ECIV 530.

ECIV 733 - Physico-chemical Properties of Soils (3 Credits)
Soil mineralogy, chemistry, and clay-water systems. Impact of soil fabric and microstructure on engineering behavior. Soil-contaminant interaction. Barriers and liners for containment.
Prerequisites: ECIV 530.

ECIV 734 - Soil Dynamics and Geotechnical Earthquake Engineering (3 Credits)
Properties and behaviors of soils under cyclic and dynamic loading. Seismic hazard assessment. Dynamic response analysis. Soil liquefaction.
Prerequisites: D or better in ECIV 530 or ECIV 531.

ECIV 736 - Ground Improvement Techniques (3 Credits)
Application of soil mechanics principles to improving the engineering characteristics of soil and rock. Topics include mechanisms of soil densification, preconsolidation, grouting, ground freezing, reinforced earth, and soil nailing.
Prerequisites: ECIV 530.

ECIV 737 - Advanced Foundation Design (3 Credits)
Application of soil mechanics to design and analysis of foundations. Shallow foundations, bearing capacity, settlement. Deep foundations, axial and lateral loading, wave equation analysis, drilled shafts. Design and construction issues.
Prerequisites: ECIV 530.

ECIV 742 - Intermodal Freight Transport (3 Credits)
Marine container terminal design and operations, rail-yard design and operations, cross-dock terminal design and operations, drayage routing and scheduling, and network design. Application of operations research techniques to intermodal transportation.
Prerequisites: D or better in ECIV 705.

ECIV 744 - Discrete Choice Analysis of Travel Demand (3 Credits)
Individual choice theory; binary choice models; unordered multinomial and multi-dimensional choice models; sampling theory and sample design; ordered multinomial models, aggregate prediction with choice models; joint stated preference and revealed preference modeling, and longitudinal choice analysis; review of state-of-the-art and future directions.
Prerequisites: D or better in STAT 509.

ECIV 746 - Flows in Transportation Networks (3 Credits)
Design, operation, and management of traffic flows over complex transportation networks. Covers two major topics: traffic flow modeling and traffic flow operations. Includes deterministic and probabilistic models, elements of queueing theory, and traffic assignment. Concepts and methods are illustrated through various applications and examples.
Prerequisites: D or better in ECIV 706.

ECIV 748 - Traffic Flow Theory (3 Credits)
Survey of statistical techniques useful in traffic engineering. Deterministic and stochastic models of traffic flow. Operations research techniques. Simulation by digital computer. Applications to highway problems.
Prerequisites: ECIV 541, STAT 509.

ECIV 750 - Principles of Environmental Engineering Process (3 Credits)
Basic physical, chemical, and biological processes applied to aqueous systems.
Prerequisites: CHEM 112 and MATH 142.

ECIV 751 - Water and Wastewater Treatment Theory I (3 Credits)
Physical and chemical water and wastewater treatment processes. Topics include mixing, coagulation, sedimentation, filtration, oxidation, absorption, and ion exchange.
Prerequisites: ECIV 750.

ECIV 752 - Water and Wastewater Treatment Theory II (3 Credits)
Biological water and wastewater treatment process. Topics include activated sludge, biofilms, nutrient removal, lagoons, and sludge treatment and disposal.
Prerequisites: ECIV 750.

ECIV 753 - Unit Operations Laboratory for Water and Wastewater Treatment (3 Credits)
Laboratory experiments in selected processes for water and wastewater treatment.
Prerequisites: ECIV 350L.

ECIV 755 - Industrial Wastewater Treatment (3 Credits)
Industrial sources, characteristics, and treatment plant design.
Prerequisites: ECIV 751 or ECIV 752.

ECIV 760 - Computational Hydraulics (3 Credits)
Unsteady flow in open channels and pipes: theory, governing equations, and methods for their solution.
Prerequisites: ECIV 560.

ECIV 761 - Numerical Methods in Subsurface Hydrology (3 Credits)
Formation of groundwater flow and solute transport problems, theory and practice, numerical methods, solution techniques.
Cross-listed course: GEOL 775

ECIV 762 - Advanced Hydrology (3 Credits)
Advanced theories and techniques used in stormwater modeling; kinematic hydrology; soil physics infiltration; deterministic and parametric stormwater models; stochastic methods.
Prerequisites: ECIV 562.

ECIV 763 - Unsaturated Flow Theory (3 Credits)
Moisture content-matric suction relationships, theory of flow in unsaturated soils, governing equations, measurement techniques, computer modeling of flow and transport.
Prerequisites: ECIV 563.

ECIV 764 - Contaminant Transport (3 Credits)
Quantitative study of conservative and non-conservative pollutant transport in groundwater. Special topics include: transport processes, field techniques to determine aquifer transport parameters, and computer modeling of flow and transport.
Prerequisites: ECIV 563.

ECIV 765 - Erosion and Sediment Control (3 Credits)
Erosion, sediment transport, methods for control, pond hydraulics and performance, nonpoint source pollution, stream water quality.
Prerequisites: ECIV 562.

ECIV 766 - Fluid Transients (3 Credits)
Definitions; derivation of governing equations; methods of solution; method of characteristics; transients caused by turbomachinery, and methods for controlling transients.
Prerequisites: ENCP 360.

ECIV 767 - Sediment Transport and River Mechanics (3 Credits)
Sediment properties, review of fluid mechanics of sediment transport as bedload and suspended load, stability analysis of bedforms, alternate bars, growth and migration of meander bends.
Prerequisites: ECIV 560.

ECIV 784 - Dynamic Analysis of Railway Systems (3 Credits)
Dynamic characteristics of railway systems and their components; Modeling and simulations of railway systems including trains, track and ballast; Dynamic interaction of components including wheel-rail and train-bridge interaction; Study of environmental vibrations; Advanced topics on infrastructure assessment, infrastructure upgrade and vibration mitigation.
Prerequisites: ECIV 524.

Prerequisite or Corequisite: ECIV 520.

ECIV 789 - Design Project in Railway Engineering (4 Credits)
Application of engineering design principles in railway projects; project management; project scheduling; cost estimation; ethics; environmental and social impact; design drawings; report documents.
Prerequisites: ECIV 580 or ECIV 582.

ECIV 790 - Selected Topics in Civil Engineering (3-9 Credits)
Individual studies and/or investigations of special topics in the field of civil engineering.

ECIV 797 - Research in Civil Engineering (1-12 Credits)
Credits to be designated upon registration.

ECIV 798 - Seminar in Civil and Environmental Engineering (0 Credits)
Seminar on current topics in civil and environmental engineering. Includes oral presentations by students on their research projects. Recommended by the department that all graduate students participate each semester the seminar series is offered.

ECIV 799 - Thesis Preparation in Civil Engineering (1-12 Credits)
To be arranged by candidates for the master's degree with the instructor under whose direction the master's thesis is being written.

ECIV 899 - Dissertation Preparation in Civil Engineering (1-12 Credits)