Department of Civil and Environmental Engineering

Degrees Offered

• Master of science in civil engineering
• Master of science in engineering with a major in civil engineering
• Doctor of philosophy with a major in civil engineering

The Department of Civil and Environmental Engineering offers the degree of master’s of science in civil engineering (M.S.C.E.). In conjunction with the Benjamin M. Statler College of Engineering and Mineral Resources, the master’s of science in engineering (M.S.E.) and the doctor of philosophy degrees are available with emphases in civil engineering.

Program Objectives

• Have the ability to work on multidisciplinary teams, have high technical competence, and have the ability to meet present and future challenges in a specialty area of civil and environmental engineering
• Have the ability to effectively plan and execute scientific research or other high-level investigations using the most current methods and techniques in the civil and environmental engineering fields
• Have the ability to effectively communicate the results of their research or investigations through writing and oral presentations
• Have the ability to contribute to the body of engineering knowledge and/or to economic growth by developing the science, the materials, and the technology necessary to deliver vital infrastructure services in the most cost effective manner while protecting the health, safety, and welfare of human society

Program Outcomes

• Graduates will have an ability to function on teams involving multiple civil engineering specialties.
• Graduates will have an ability to apply advanced methodologies in their specialty area.
• Graduates will have an ability to effectively communicate technical information.
• Graduates will have an ability to design and conduct experiments, analyze and interpret data, and develop recommendations.
• Graduates will have an understanding of professional and ethical responsibility.
• Graduates will have an ability to understand the impact of engineering solutions in global and societal context.
• Graduates will have a recognition of the need to engage in life-long learning.
• Graduates will have an ability to use contemporary techniques, skills, and tools necessary for engineering practice in education, industry, and/or government.

Student Learning Outcomes

• Graduates will meet the academic standards required by WVU for those in graduate school while completing courses pertinent to their specialty area and as specified in their plan of study.
• Graduates will conduct experimental or investigatory work necessary to satisfy the requirements of either the thesis option or report option for graduation.
• Graduates will write and orally defend a thesis, a report, or a dissertation.
• Graduates will serve in primary roles as graduate research assistants on research projects or on problem investigations sponsored by companies, associations, or government agencies looking for new methodology or science to resolve problems associated with the planning, design, construction, operation, and maintenance of the infrastructure or for related needs.

Areas of Emphasis

There are four major areas of interest of the faculty and graduate studies:

• Environmental and hydro-technical engineering, which includes wetland and natural stream restoration; water, waste water, and industrial waste treatment; site remediation; groundwater hydraulics, hydrology, sediment transport, fluid mechanics, water and health, and satellite remote sensing of hydrological processes
• Geotechnical engineering, which includes soil mechanics, foundations engineering, soil-structure interaction, geomechanics, geoenvironmental, groundwater and seepage, geosynthetics, contaminant transport, earthwork design, and waste by-product utilization
• Transportation engineering, which includes planning, design, construction, operations, and maintenance of transportation facilities/systems (roadways, railroads, airports, and public transportation) as well as related areas of infrastructure management and expert systems
• Structural engineering, which includes advanced structural mechanics, structural dynamics, bridge engineering, building design for static and dynamic loads, advanced materials for civil infrastructure, and nondestructive testing and evaluation
Faculty

The Department of Civil and Environmental Engineering has a full-time faculty of twenty-three who are active in teaching, research, and professional commitments. Many of the faculty members are licensed professional engineers registered in one or more states and are involved in state, regional, and national professional organizations, serving on numerous technical committees. They are successful researchers and have published extensively in technical journals. The Civil and Environmental Engineering faculty produces graduates who can assume the problem solving, decision-making, and technical leadership roles of a professional engineer and who have the sound educational background for the continuing professional development the field requires.

Students tailor their program of study to pursue individual topics of interests with guidance from a faculty advisor. Opportunities abound within the master’s and doctoral tracks for a research experience in which the student tackles an engineering problem individually with guidance from a faculty advisor. The graduate program in civil engineering was established with the aim of developing its students’ abilities to use today’s contemporary methods of engineering analysis and design to solve tomorrow’s engineering problems.

FACULTY

CHAIR
• Radhey Sharma - Ph.D. (University of Oxford)
  Sustainable Infrastructure, Geotechnical Engineering and Geoenvironmental, Energy Engineering

PROFESSORS
• Hung-Liang (Roger) Chen - Ph.D. (Northwestern University)
  Structural Dynamics, Structural Experimentation, Dynamic Soil-Structure Interaction, Damage in Reinforced Concrete Structures, Nondestructive Evaluation, Concrete
• Hota GangaRao - Ph.D., P.E. (North Carolina State University)
  Maurice A. and Jo Ann Wadsworth Distinguished Professor, Director of the Constructed Facilities Center, Director of the NSF Center for Integration of Composites into Infrastructure, Mathematical Modeling of Engineering Systems, Bridge Engineering, Composite Material Characterization and Implementation
• Udaya B. Halabe - Ph.D., P.E. (Massachusetts Institute of Technology)
• David R. Martinekeli - Ph.D. (University of Maryland)
  Transportation Engineering, Traffic Operations, Systems Analysis, Infrastructure Management
• Hema J. Siriwardane - Ph.D., P.E. (Virginia Polytechnic Institute and State University)
  Geomechanics/Geotechnical Engineering, Finite Element Method, Computer Applications
• John P. Zaniewski - Ph.D., (University of Texas)
  Asphalt Technology Professor, Pavement Materials, Design, Construction, Maintenance, Infrastructure Management

ASSOCIATE PROFESSOR
• Karl Barth - Ph.D. (Purdue University)
  Jack H. Samples Distinguished Professor of Structures, Steel Structures, Bridge Design and Rehabilitation, Connections, Stability Analysis, Experimental Mechanics
• Lian-Shin Lin - Ph.D., P.E. (Purdue University)
  Physiochemical and Biological Treatment, Innovative Wastewater Technologies, Emerging Coaminants, Sustainable Development, Watershed Pollution

ASSISTANT PROFESSORS
• Fei Dai - Ph.D. (Hong Kong Polytechnic Univeristy)
  Construction Engineering, Construction Management, Construction Information Technologies
• Leslie Clark Hopkinson - Ph.D. (Virginia Polytechnic Institute and State Univeristy)
  Surface Hydrology, Environmental Hydraulics, Ecological Engineering, River Mechanics
• Antarpreet Jutla - Ph.D. (Tufts University)
• John D. Quaranta - Ph.D., P.E. (West Virginia University)
• Avinash Unnikrishnan - Ph.D. (University of Texas, Austin)
  Transportation Network Analysis and Planning, Freight Network Analysis and Logistics, Intelligent Transportation Systems
• P.V. Vijay - Ph.D. (West Virginia University)
Concrete Structures; P Composite Structures for Bridges, Buildings, and Pavements; Aging of Structures and Rehabilitation, Recycled Polymers for Infrastructure, Analytical Modeling
• Jennifer L. Weidhaas - Ph.D., PE (University of California-Davis)
  Biotechnology, Bioenergy Production, Remediation of Emerging Contaminants in Soils and Ground Water
• Yoojung Yoon - Ph.D. (Purdue University)
  Infrastructure Asset Management, Risk Management in Construction, Project Management and Control, Construction Equipment Management

RESEARCH ASSISTANT PROFESSORS
• Eduardo Sosa - Ph.D. (University of Puerto Rico)
• Gergis William - Ph.D., P.E. (West Virginia University)
  Civil Infrastructure, Bridge Design and Diagnosis, Thermal Stress Analysis, Nonlinear Finite Element Analysis, Advanced Materials and Structures

PROFESSORS EMERITUS
• Ronald W. Eck - Ph.D. (Clemson University)
• Donald Gray - Ph.D. (Purdue University)
• W. Joseph Head - Ph.D. (Purdue University)
• Charles R. Jenkins - Ph.D. (Oklahoma State University)
• Larry D. Luttrell - Ph.D. (Cornell University)
• William A. Sack - Ph.D. (Michigan State University)

ASSOCIATE PROFESSORS EMERITUS
• Robert N. Eli - Ph.D. (University of Iowa)
• Darrell R. Dean, Jr. - Ph.D. (Purdue University)

Admission
To be eligible for admission into the M.S.C.E. degree program, a candidate must fulfill either of the following:
• Hold or expect to receive a B.S.C.E. degree from either an accredited ABET curriculum or an internationally recognized program
• Have a superior academic record and a baccalaureate degree in another engineering field, mathematics, or science

Candidates with a baccalaureate degree in another field of engineering, mathematics, or science are also eligible for admission into the M.S.E. degree. Candidates are normally required to attain a baccalaureate level of proficiency in areas of emphasis of the department. An engineering technology (non-calculus based) degree is not sufficient qualification for admission into any of the graduate programs offered by the department.

To be eligible for admission into a doctorate of engineering program, a candidate is expected to hold or expect to receive a B.S. or an M.S. degree or equivalent in the following:

A discipline of engineering from an institution which has an ABET accredited program in that discipline which has an internationally recognized program in engineering, or mathematics and sciences (as specified by individual programs).

The other requirements for admission into the graduate programs of the department are summarized as follows:
• Grade point average of 3.0 or better (out of a possible 4.0) in all previous college work and must meet all other requirements below.
• Three reference letters; at least two of the three references should be from the institution the applicant last attended.
• International students must demonstrate proficiency in communicating in English (a minimum TOFEL score of 550, or iBT score of 79, or IELTS score of 6.5) (Students who have completed a recent four-year bachelor's degree in the USA need not submit these scores.)
• All applicants are encouraged to submit GRE scores for fellowship and funding options. Applicants who have not received their undergraduate degree in the United States are required to submit GRE General Test scores with the Engineering Subject Test score being optional.

Provisional Admission
An applicant who is not qualified for regular graduate student admission status, due either to insufficient grade-point average, incomplete credentials, or inadequate academic background, can be admitted as a provisional student. Requirements for attaining regular student status must be stated in the letter of admission. Provisional students must sign a contract, which lists these requirements in detail, no later than their first registration.
Masters of Science in Civil Engineering

Students must comply with rules and regulations as outlined in the general requirements for graduate work. Each candidate will, with the approval and at the discretion of the graduate committee, follow a planned program which must conform to one of the following outlines:

- A minimum of thirty semester credit hours, not more than six of which are in research leading to an acceptable thesis
- A minimum of thirty-three semester credit hours, not more than three of which are in research leading to an acceptable problem report
- A minimum of thirty-six semester credit hours, with no thesis or problem report required (Although rarely permitted, this option is open to students with practical engineering experience or those who have demonstrated an ability to organize and develop a project and write a technical report. Approval to pursue this option must be obtained from the student’s advisory and examining committee (AEC), the graduate program coordinator, and the department chairperson.)

No rigid curricula are prescribed for the degree of master of science in civil engineering. Graduate-level work in mathematics, mechanics, or other appropriate areas of science is customary; however, at least fifteen semester hours of credit should normally be selected from graduate civil engineering courses.

Thesis and Problem Report

A thesis or problem report is normally required of all candidates. While required credit in research (CE 697) is devoted to the thesis or report preparation, the thesis or problem report is not automatically approved after the required number of semester hours of research work has been completed. The thesis or problem report must conform with the general WVU requirements for graduate study and to any additional requirements established by the department.

Examinations

A candidate shall be required to pass an examination which may be written or oral or both, to be administered by the student’s advisory and examining committee. The examination shall cover course material and the thesis or problem report, depending upon the program followed.

Master of Science in Engineering

The master of science in engineering program is available to students approved for the graduate program who possess a baccalaureate degree in a technical area other than civil engineering. Students entering this graduate program must complete appropriate undergraduate work as specified by the advisory and examining committee. In addition to fulfilling the required undergraduate work, the M.S.E. program must follow a planned program meeting one of the three options for the M.S.C.E. as specified above. No rigid curricula are prescribed for the degree of master of science in engineering. Graduate-level work in mathematics, mechanics, or other appropriate areas of science is customary; however, at least fifteen semester hours of credit should normally be selected from graduate civil engineering courses. This degree program is administered by the Statler College of Engineering and Mineral Resources; the program may emphasize civil engineering.

Doctor of Philosophy

The doctor of philosophy degree is administered through the college’s interdisciplinary program; civil engineering may be the major. A candidate for the degree of doctor of philosophy must comply with the rules and regulations outlined in the general requirements of the Statler College of Engineering and Mineral Resources. The research work for the doctoral dissertation must show a high degree of originality on the part of the student and must constitute an original contribution to the art and science of civil engineering.

GRADUATE COMMITTEE

For the Ph.D. program, the student, research advisor, academic advisor, and department chairperson appoint the student’s AEC. Each committee must consist of at least five members, with at least three members from CEE, and at least one from outside the department. By the end of the Ph.D. student’s second semester, the student, with the advice and consent of the academic advisor, graduate coordinator, and members of the student’s AEC, submits a plan of study, initiated in CEE, to the dean.

REQUIRED COURSEWORK

Specific course requirements are determined by the student’s advisory and examining committee (AEC) with approval of the graduate coordinator and department chairman. A minimum of eighteen semester hours of course work at WVU is required at the 500 and higher-levels with an average of 3.0 or better. A minimum of twenty-four credit hours in research leading to an acceptable dissertation are required. The coursework and research requirements are in addition to a master’s degree; civil engineering does not currently have a direct Ph.D. program.

QUALIFYING EXAMINATION

All Ph.D. students must pass the qualifying examination given in their first year at WVU. This examination is designed to assess the fundamental knowledge of students in the field of civil engineering and to determine their intrinsic ability to undertake independent research.
RESEARCH PROPOSAL

After passing the qualifying examination, the student must submit to the AEC a written research proposal of his/her planned dissertation work and successfully defend it in an oral examination. The research proposal must be approved by the student’s AEC. A student who has successfully completed all coursework, passed the qualifying examination, and successfully defended the research proposal, and receives the college’s approval becomes a candidate for a Ph.D. degree in CE. Thereafter, the student will officially be engaged in dissertation research. At the completion of the dissertation research, the candidate must prepare a dissertation and defend it orally at the final defense conducted by the AEC. Each student must satisfy the university and the college Ph.D. program requirements.

COURSES

CE 511. Pavement Design. 3 Hours.
PR: CE 451 or consent. Effects of traffic, soil, environment, and loads on the design and behavior of pavement systems. Design of pavement systems. Consideration of drainage and climate. Pavement performance and performance surveys. (3 hr. rec.).

CE 515. Flexible Pavements. 3 Hours.
Design, construction and mathematics of flexible pavements, including material characterization, mix design, construction methods, pavement design and evaluation, and maintenance procedures.

CE 520. Groundwater Dynamics. 3 Hours.
PR: Consent. Introduction to groundwater, formulation of equations for saturated and unsaturated flow, analytical solutions for steady and transient cases, transport of pollutants, and numerical techniques. (3 hr. lec.).

CE 522. Free Surface Hydrodynamics. 3 Hours.
PR: CE 322 or consent. The dynamics of liquid flow with a free surface under the influence of gravity; open channel hydraulics, wave motion, and buoyancy effects. (3 hr. lec.).

CE 524. Groundwater Engineering. 3 Hours.
PR:CE 322 or consent. Introduction to the nature, hydrology, mechanics, technology, and quality of groundwater. Well solutions in confined, leaky, and unconfined aquifers. Modeling concepts and public-domain computer programs.

CE 530. Prob/Relib/Stat Mth- Engr Dsgn. 3 Hours.
PR: Consent. Accounting for influence of uncertainty and reliability in analysis and design of Civil Engineering systems.

CE 531. Pedestrian/Bike Transportation. 3 Hours.
Planning, design, operation and maintenance of pedestrian and bicycle facilities, including multi-use trail, and in-depth examination of policies, programs and design principles to encourage non-motorized travel.

CE 533. Geomet Design of Highway. 3 Hours.
PR: Consent. The theory and practice of geometric design of modern highways, horizontal and vertical alignment, cross-slope, design speed, sight distances, interchanges, and intersections. Critical analysis of design specifications. (2 hr. lec., 3 hr. lab.).

CE 534. Intro to Traffic Engineering. 3 Hours.
PR:CE 332 or consent. The purpose, scope, and methods of traffic engineering. Laboratory devoted to conducting simple traffic studies, solving practical problems, and designing traffic facilities. (2 hr. lec., 3 hr. lab.).

CE 538. Highway Safety Engineering. 3 Hours.
PR: CE 431 or consent. Relationship between human, vehicular, and roadway factors which impact safety; functional requirements of highway safety features; legal aspects; accident analysis; evaluation of highway safety projects. (3 hr. lec.).

CE 539. Traffic Engineering Operations. 3 Hours.
PR: CE 534. Theory and practice of application of traffic engineering regulations; traffic control concepts for urban street systems and freeways; freeway surveillance and incident management; driver information systems; traffic control system technology and management. (3 hr. rec.).

CE 540. Environment Chemistry/Biology. 3 Hours.
PR:CE 322 or consent. Study of physical and chemical properties of water. Theory and methods of chemical analysis of water, sewage, and industrial wastes. Biological aspects of stream pollution problems. (2 hr. lec., 3 hr. lab.).

CE 542. Physicochemical Treatment. 3 Hours.
PR: CE 347 or consent. Engineering topics on water and wastewater treatment based on pollutant’s physical and chemical characteristics will be presented, including human health concerns related to water, regulations, reactor theory, transport phenomena, and various treatment technologies.

CE 543. Water Quality Modeling-Analysis. 3 Hours.
PR: CE 347 or consent. Theories, methodologies and data analyses will be presented for water quality modeling in surface and groundwater, and for determining water quality distributions, trends, and compliance with regulatory standards.

CE 546. Prin Biological Waste Treatmnt. 3 Hours.
PR: CE 540 or consent. Examination of biological treatment systems related to microbiology and function. Models used to describe system behavior and kinetics are developed. Laboratory and field experiments are performed to understand the relation between operation and design. (2 hr. lec, 3 hr. lab.).
CE 547. Applied Wetlands Ecol & Mgmt. 3 Hours.
The management and ecology of wetland vegetation, soils, hydrology, and wildlife. (Offered in fall of odd years. Also listed as WMAN 547 and PLSC 547).

CE 549. Solid/Hazardous Waste Managmnt. 3 Hours.
PR: Consent. Patterns and problems of solid waste storage, transport, and disposal. Examinations of various engineering alternatives with appropriate consideration for air and water pollution control and land reclamation. Analytical approaches to recovery and reuse of materials. (2 hr. lec., 3 hr. lab).

CE 550. Soil Properties and Behavior. 3 Hours.
PR: CE 451 or consent. Soil mineralogy and the physicochemical properties of soils and their application to understanding of permeability, consolidation, shear strength, and compaction. Prediction of engineering behavior of soils in light of physicochemical concepts. (3 hr. lec).

CE 551. Soil Testing. 3 Hours.
PR: CE 351 or consent. Experimental evaluation of soil properties and behavior. Emphasis is placed on the proper interpretation of experimental results and application of such results to practical problems. (1 hr. lec., 6 hr. lab).

CE 552. Finite Element Method. 3 Hours.
PR: Graduate standing in CE or MAE or consent. Introductory treatment of theoretical basis of finite element method, mathematical formulation, different types of elements, stress analysis in solids, applications, and computer implementation.

CE 553. Advanced Finite Element Methods. 3 Hours.
PR: Consent. Formulation procedures and applications of finite element methods to two- and three-dimensional problems, techniques for nonlinear analysis, computer implementation, applications in field problems, flow, and dynamics.

CE 561. Stat Indeterminate Structures. 3 Hours.
PR: CE 461 or consent. Force and displacement methods of analysis; energy principles and their application to trusses, frames, and grids; effects of axial forces; influence lines for frames, arches, and trusses; secondary stress analysis. (3 hr. lec).

CE 563. Intro Structural Dynamics. 3 Hours.
PR: CE 561 PR: CE 561. General theory for dynamic response of systems having one or several degrees of freedom. Emphasis on the application of dynamic response theory to structural design. (3 hr. lec.).

CE 564. Nonstrct Mtrl/Strctl Evl. 3 Hours.
PR: Consent. Nondestructive evaluation (NDE) using techniques based on mechanical and electromagnetic wave propagation; theory and applications of various NDE techniques including infrared thermography, dynamic characterization, seismic reflection and refraction, ultrasonics, acoustic emission, and radar. (3 hr. lec).

CE 566. Adv Materials-Infrastructure. 3 Hours.
PR: CE 462 and CE 463. Introduction to principles of material science; material structure, characterization at coupon and component level, practical information on fiber-reinforced shapes; establishment of failure analysis and standardization. (3 hr. lec).

CE 567. Prestressed Concrete. 3 Hours.
PR: CE 461 and CE 462 or consent. Behavior and design of prestressed concrete members. Materials, bending, shear, torsion, methods of prestressing, prestress losses, deflections, compression members, composite members, and indeterminate structures. (3 hr. lec).

CE 591A-Z. Advanced Topics. 1-6 Hours.
PR: Consent. Investigation of advanced topics not covered in regularly scheduled courses.

CE 593A-Z. Special Topics. 1-6 Hours.
A study of contemporary topics selected from recent developments in the field.

CE 594A-Z. Seminar. 1-6 Hours.
Special seminars arranged for advanced graduate students.

CE 697. Research. 1-15 Hours.
PR: Consent. Research activities leading to thesis, problem report, research paper or equivalent scholarly project, or a dissertation. (Grading may be S/U).

CE 721. Environmental Fluid Mechanics. 3 Hours.
PR: Consent. Equations of motion including buoyancy and Coriolis force; mechanics of jets and plumes; diffusion, dispersion, and mixing in rivers, lakes, reservoirs, and estuaries. (3 hr. lec).

CE 722. Deterministic Hydrology. 3 Hours.
PR: Consent. An in-depth treatment of the dynamics of the accumulation of runoff, including the formulation of the unsteady surface flow equations and the unsteady saturated-unsaturated subsurface flow equations. Both analytical and numerical solutions are presented with applications. (3 hr. lec).

CE 732. Transportan Systems Analysis. 3 Hours.
PR: Consent. Systematic examination of the interaction between transport technology, activity systems, and traffic flows. Quantitative analysis of the relationship among vehicle cycles, networks, congestion, choice behavior, cost functions, and resulting travel-market equilibrations. (3 hr. lec).

CE 744. Industrial/Adv Waste Treatment. 3 Hours.
PR or Conc: CE 540 or consent. Basic physical and chemical unit operations used in industrial and advanced waste treatment; applications for waste water reclamation and reuse; study of industrial wastes from standpoint of process, source, and treatment. (2 hr. lec., 3 hr. lab).
CE 751. Adv Mechanics Of Soils. 3 Hours.
PR: CE 351 and CE 551 and MAE 640 or consent. Stress invariants, stress history and stress path, elastic and quasi-elastic models for soils; soil plasticity, failure theories for soils; critical state soil mechanics, and determination of construction parameters. (3 hr. lec.).

CE 752. Adv Foundation Analysis. 3 Hours.
PR: CE 451 or consent. Study of soil-structure interaction. Applications of principles of soil mechanics and numerical methods for analysis and design of geotechnical structures: strip footings, axially and laterally loaded piles, braced excavations, sheet pile walls, tunnel lining, and buried pipes and culverts. (3 hr. lec.).

CE 753. Adv Earthwork Design. 3 Hours.
PR: CE 453 or consent. Application of the principles of theoretical soil mechanics to the design of embankments of earth and rock. In-depth study of compaction theory, and stability of natural and man-made slopes by limit equilibrium and deformation considerations. (3 hr. lec.).

CE 754. Groundwater And Seepage. 3 Hours.
PR: Consent. Flow of groundwater through soils and its application to the design of highways and dams and to construction operations. Emphasis is placed on both the analytical and classical flow net techniques for solving seepage problems. (3 hr. lec.).

CE 756. Soil Dynamics. 3 Hours.
PR: CE 550 and consent. Consideration of the simple damped oscillator, wave propagation in elastic media, dynamic field and laboratory tests, dynamic soil properties, and foundation vibrations. Introduction to geotechnical aspects of earthquake engineering. (3 hr. lec.).

CE 760. Finite Elmt Mtd Strct Anl. 3 Hours.
PR: CE 561 or consent. Relationships of elasticity theory; definitions and basic element operations; direct and variational methods of triangular and rectangular elements related to plane stress, plane strain, and flat plates in bending; variational principles in global analysis. (3 hr. lec.).

CE 761. Bridge Engineering. 3 Hours.
PR: CE 561 or consent. Statically indeterminate trusses, continuous trusses; steel and concrete arches; long-span and suspension bridges; secondary stresses. (3 hr. lec.).

CE 763. Behavior Of Steel Member. 3 Hours.
PR: CE 463 or consent. Elastic behavior of steel members subjected to axial load, bending, and torsion. Elastic and inelastic response of beams, columns, and beam-columns to load and the resulting design implications. Comparison with standard steel codes and specifications. (3 hr. lec.).

CE 765. Structural Design-Dynamic Load. 3 Hours.
PR: CE 563 or consent. Nature of dynamic loading caused by earthquakes and nuclear weapons blasts; nature of dynamic resistance of structural elements and structural systems; criteria for design of blast-resistance and earthquake-resistant structures; simplified and approximate design methods. (3 hr. lec.).

CE 767. Behavr-Reinfrd Concrete Membr. 3 Hours.
PR: CE 462 or consent. Studies of actual member behavior; members in flexure, combined flexure, shear, and torsion; bond and anchorage; combined axial load and flexure; slender columns; deep beams; derivation of current code provisions. (3 hr. lec.).

CE 768. Behavior/Design of FRP Members. 3 Hours.
PR: Consent. Studies of fiber reinforced polymer (FRP) composite member behavior including rebars and wraps for concrete, under flexure, axial, shear forces, and combined effects; design, durability, and rehabilitation of FRP members and systems including field applications.

CE 790. Teaching Practicum. 1-3 Hours.
PR: Consent. Supervised practice in college teaching of civil engineering. Note: This course is intended to insure that graduate assistants are adequately prepared and supervised when they are given college teaching responsibility. It will also present a mechanism for students not on assistantships to gain teaching experience. (Grading will be S/U.).

CE 791A-Z. Advanced Topics. 1-6 Hours.
PR: Consent. Investigation of advanced topics not covered in regularly scheduled courses.

CE 792A-Z. Directed Study. 1-6 Hours.
Directed study, reading, and/or research.

CE 793A-Z. Special Topics. 1-6 Hours.
A study of contemporary topics selected from recent developments in the field.

CE 794A-Z. Seminar. 1-6 Hours.
Special seminars arranged for advanced graduate students.

CE 795. Independent Study. 1-9 Hours.
Faculty supervised study of topics not available through regular course offerings.

CE 796. Graduate Seminar. 1 Hour.
PR: Consent. Each graduate student will present at least one seminar to the assembled faculty and graduate student body of his or her program.

CE 797. Research. 1-15 Hours.
PR: Consent. Research activities leading to thesis, problem report, research paper or equivalent scholarly project or dissertation. (Grading may be S/U.).
CE 798. Dissertation. 1-6 Hours.
PR: Consent. This is an optional course for programs that wish to provide formal supervision during the writing of student reports (698), or dissertations (798). Grading is normal.

CE 799. Graduate Colloquium. 1-6 Hours.
PR: Consent. For graduate students not seeking coursework credit but who wish to meet residency requirements, use the University’s facilities, and participate in its academic and cultural programs. Note: Graduate students who are not actively involved in coursework or research are entitled, through enrollment in their department’s 699/799 Graduate Colloquium to consult with graduate faculty, participate in both formal and informal academic activities sponsored by their program, and retain all of the rights and privileges of duly enrolled students. Grading is S/U; colloquium credit may not be counted against credit requirements for masters programs. Registration for one credit of 699/799 graduate colloquium satisfies the University requirement of registration in the semester in which graduation occurs.

CE 900. Professional Development. 1-6 Hours.
Professional development courses provide skill renewal or enhancement in a professional field or content area (e.g., education, community health, geology). The continuing education courses are graded on a pass/fail grading scale and do not apply as graduate credit toward a degree program.