CIVIL AND INFRASTRUCTURE ENGINEERING (CEIE)

100 Level Courses

CEIE 100: *Environmental Issues and Solutions Around the World.* 3 credits.
Society's relationship with the environment is: (1) fundamental to its success; (2) complex, involving economics, finance, law, culture, religion, politics, education, science, technology, and engineering; (3) widespread, often with impacts not just locally but regionally, nationally or globally; and (4) constantly changing with potentially enormous short-term and long-term benefits and costs that may be in conflict. This relationship can drive a society to thrive or decline. Humans today have unprecedented ability to affect the environment both locally and globally, and to be affected by it. Technology and engineering are key drivers in society's efforts to manage our environment. This course will examine the history of various societies' interactions—including our own—with the environment; explore our ability to affect the environment—in small and enormous ways—through modern science, technology and engineering; and foster debate on today's critical environmental issues. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Mason Core: Mason Core, Global Contexts, Global Understanding, Just Societies, Encore: Sustainability (https://catalog.gmu.edu/mason-core/)

Specialized Designation: Green Leaf Related Course

Registration Restrictions:
Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 101: *Introduction to Civil Engineering.* 2 credits.
This course introduces the profession of civil engineering, with specific emphasis on modern challenges and solutions that are internal and external to the domain of civil engineering. Topics include broad coverage on technology-driven solutions to traditional engineering problems such as geodesy and georeferencing; global positioning systems; remote sensing; infrastructure security; civil engineering; big data; structural health monitoring; and cyber-physical systems. Using the principles taught in the course, for the term project students will develop solutions to meet the United Nations Sustainable Development Goals to Transform the World. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Registration Restrictions:
Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

200 Level Courses

CEIE 203: *Geomatics and Engineering Graphics.* 3 credits.
Introduces topographic surveying and engineering drawing for civil engineering applications. Topics include surveying, GPS, GIS, digital terrain modeling, design of horizontal and vertical curve geometry for road applications, engineering drawing concepts, and drawing with CAD-based software. Fieldwork required on selected topics. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Registration Restrictions:
Required Prerequisites: (CDS 130[C], 130[XS], CS 109[C], 109[XS], 112[C], 112[XS], SYST 130[C], 130[XS] or ENGR 125T).
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 210: *Statics.* 3 credits.
Covers force vectors and operations in 2D and 3D; equilibrium of a particle; moment of a force vector; equilibrium of a rigid body; truss analysis; center of gravity, centroid and moment of inertia; shear force and bending moment diagrams; dry friction; virtual work. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts. Equivalent to ME 211.
Registration Restrictions:
Required Prerequisites: (PHYS 160[C] or 160[XS]) and (MATH 114[C], 114[XS], 116[C] or 116[XS]).
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 240: *Hydraulics.* 3 credits.
Principles of fluids in equilibrium and motion. Topics include hydrostatic pressure; continuity, Bernoulli, and momentum equations; viscosity flow problems; pressure pipe flow and turbomachinery; measuring instruments; and applications to closed conduits and open channels. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts. Equivalent to CEIE 241.
Registration Restrictions:
Required Prerequisites: (PHYS 160[C] or 160[XS]).
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Laboratory, Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 241: *Hydraulics.* 3 credits.
Principles of fluids in equilibrium and in motion. Topics include hydrostatic pressure; continuity, Bernoulli, and momentum equations; viscosity flow problems; measuring instruments; and applications to pressure pipe and open channel flow systems. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Registration Restrictions:
Required Prerequisites: (PHYS 160[C] or 160[XS]) and CEIE 242[*C].
[*] May be taken concurrently.
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 242: *Hydraulics Laboratory.* 1 credit.
Principles of fluids in equilibrium and in motion. Topics include hydrostatic pressure; continuity, Bernoulli, and momentum equations; viscosity flow problems; measuring instruments; and applications to pressure pipe and open channel flow systems. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Registration Restrictions:
Required Prerequisites: (PHYS 160[C] or 160[XS]) and CEIE 241[*C].
[*] May be taken concurrently.
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Schedule Type: Laboratory

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

300 Level Courses

CEIE 301: *Engineering and Economic Models in Civil Engineering.* 3 credits.
Applies planning, analysis, control, and engineering economic models to life cycle of physical infrastructure. Introduces infrastructure design process and application of quantitative and probabilistic models. Presents applications of model building for engineering economics; decision making; forecasting; resource scheduling and allocation; estimating; work measurement and materials; and quality and process control in water, transportation, environmental, energy, and telecommunications infrastructure systems and the built environment. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Mason Core: Mason Core, Writing Intensive in Major (https://catalog.gmu.edu/mason-core/)

Registration Restrictions:
Required Prerequisites: (STAT 344[C], 344[XS], L344, 260[C] or 260[XS]) and (ENGL 302[C], ENGH 302[C], 302[XS], ENGL L302, ENGH L302, HNRS 353[C], 360[C] or 360[XS]).
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Enrollment is limited to students with a major in Civil and Infrastructure Engr.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 310: *Mechanics of Materials.* 3 credits.
Concepts of stress, strain, elasticity, and plasticity. Stress and strain transformation, including the use of Mohr's circle. Pure torsion. Theory of pure bending and members under transverse loading, including normal and shear stress analysis. Theory of elastic buckling. Distribution of internal forces in statically determinate systems and deflection of beams. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts. Equivalent to ME 212.
Registration Restrictions:
Required Prerequisites: (ENGR 210[C], CEIE 210[C], 210[XS], ME 211[C] or 211[XS]).
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Enrollment is limited to students with a major in Civil and Infrastructure Engr or Systems Industrial Enginrng.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 311: *Structural Analysis.* 3 credits.
Basic concepts and assumptions of structural analysis, including statical and geometric redundancy. Analysis, by integration of deformation of simple structural members. Virtual work method for the analysis of deformations of simple structural systems such as articulate beams, trusses, frames, and arches. Method of forces to analyze statically indeterminate systems, method of displacements to analyze geometrically indeterminate systems, and symmetry and antisymmetry in structural analysis. Uses computer programs for structural analysis. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Registration Restrictions:
Required Prerequisites: (ENGR 310[C], L310, CEIE 310[C], L310 or 310[XS]).
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Enrollment is limited to students with a major in Civil and Infrastructure Engr.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Lecture, Recitation

Grading:

This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 331: *Soil Mechanics.* 3 credits.
Covers soil classification, soil properties and engineering characteristics of soils. Includes seepage effects, effective stresses, soil strength and deformation characteristics. Also, the determination of immediate and consolidation settlement, lateral earth pressures and bearing capacities. Introduces foundation design fundamentals. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Registration Restrictions:
Required Prerequisites: (ENGR 210[C], CEIE 210[C] or 210[XS]) and (CEIE 230[C], 240[C] or 240[XS]).
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Enrollment is limited to students with a major in Civil and Infrastructure Engr.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Laboratory, Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 332: *Soil Mechanics.* 3 credits.
Covers soil classification, soil properties and engineering characteristics of soils. Covers the methods used to describe soils qualitatively and quantitatively: phase diagram, grain size distribution, total and effective stresses, compaction, consolidation, hydraulic conductivity, and strength of soils. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Registration Restrictions:
Required Prerequisites: (ENGR 210[C], CEIE 210[C] or 210[XS]) and (CEIE 230[C], 240[C] or 240[XS]) and (CEIE 333[*C]).
[*] May be taken concurrently.
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Enrollment is limited to students with a major in Civil and Infrastructure Engr.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 333: *Soil Mechanics Lab.* 1 credit.
Hands-on soil laboratory including soil classification, soil properties and engineering characteristics of soils, methods used to describe soils qualitatively and quantitatively, grain size distribution, plasticity, compaction, and hydraulic conductivity. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Registration Restrictions:
Required Prerequisites: (ENGR 210[C], CEIE 210[C] or 210[XS]) and (CEIE 230[C], 240[C] or 240[XS]) and (CEIE 332[*C]).
[*] May be taken concurrently.
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Enrollment is limited to students with a major in Civil and Infrastructure Engr.

Schedule Type: Laboratory

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 340: *Water Resource Engineering.* 3 credits.
Introduces principles and practice of water resources engineering. Topics include hydrology, governing principles, design and evaluation methods, common models, and typical applications in water resource engineering. Laboratory and field work required on selected topics. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Registration Restrictions:
Required Prerequisites: (CEIE 230[C], U230, 240[C], 240[XS] or U240) or ((CEIE 241[C] and 242[C])).
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Enrollment is limited to students with a major in Civil and Infrastructure Engr.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 355: *Environmental Engineering and Science.* 3 credits.
Introduces students to the concepts of water pollution, air pollution, noise, and solid waste generation and management. Relationships between human population growth and pollution are introduced. Contemporary environmental engineering topics such as sustainability and global climate change are presented. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Specialized Designation: Green Leaf Related Course

Registration Restrictions:
Required Prerequisites: (CHEM 211[C], U211, 211[XS], 251[C], U251, 271[C] or 271[XS]) and ((CEIE 230[C], U230, 240[C], U240 or 240[XS]) or (CEIE 241[C] and 242[C])).
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Enrollment is limited to students with a major, minor, or concentration in Civil and Infrastructure Engr, Environmental Engineering, Energy Transition Management, Systems Industrial Enginrng or Sustainability Studies.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 360: *Introduction to Transportation Engineering.* 3 credits.
Introduces transportation systems and the factors that influence their planning, design, and operation. Topics include fundamentals of urban travel, travel demand forecasting, and traffic flow; principles of highway design; highway capacity and level of services; introduction to traffic control; traffic signal control systems; intersection design; speed zoning and control; and introduction to Intelligent Transportation Systems and travel demand management. Requires laboratory, field work on selected topics. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Registration Restrictions:
Required Prerequisites: (CEIE 290[C], U290, 203[C], 203[XS] or U203) and (ENGR 210[C], U210, CEIE 210[C], 210[XS] or U210).
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Enrollment is limited to students with a major in Civil and Infrastructure Engr.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 370: *Construction Systems.* 3 credits.
Overview of the modern construction industry and principles and practices of construction management. Topics include project planning, construction administration, the contract environment, equipment operations, cost estimation and scheduling, and legal theories. Current industry trends are emphasized as are the uses of modern scheduling and cost-estimating software and online databases. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Registration Restrictions:
Required Prerequisites: CEIE 290[C], 203[C], 203[XS] or U290.
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Enrollment is limited to students with a major in Civil and Infrastructure Engr.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 395: *Mentored Research in Civil and Environmental Engineering.* 1-3 credits.
Introduces the scientific research process through hands-on experience: students are matched with faculty mentors who are actively involved in civil engineering-related research. Requires no less than 60 hours per semester working with mentors. Notes: Three credits of CEIE 395 may substitute for a maximum of 3 credits of CEIE 4xx technical elective credits with department permission. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May be repeated within the degree for a maximum 6 credits.
Specialized Designation: Mason Impact., Research/Scholarship Intensive

Recommended Prerequisite: At least 60 credit hours applicable to the Civil and Infrastructure Engineering program.

Registration Restrictions:
Enrollment is limited to students with a major in Civil and Infrastructure Engr.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Independent Study

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

400 Level Courses

CEIE 401: *Sustainable Land Development.* 3 credits.
Introduces students to sustainable land development topics including low impact development, site resource conservation, ultra-low water design, deconstruction and materials reuse, healthy building design, green house gas reduction, zero and low energy design, and other topics related to sustainable practices in facilities and infrastructure design and construction. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Specialized Designation: Green Leaf Focused Course

Registration Restrictions:
Required Prerequisites: (CEIE 355[C], 355[XS] or L355) and (CEIE 340[C] or 340[XS]).
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 402: *Highway Design and Construction.* 3 credits.
Provides a survey of the tools, techniques, and methods used by the various civil engineering disciplines to design and construct highways. Combines lectures, individual readings, and hands-on exposure to the tools and processes used in design and construction of highways. All facets of a project are covered including planning, project management, survey and mapping, preliminary design, geotechnical, pavements, environmental, hydraulics, bridge design, PS&E design, materials, and construction. Notes: Course meets off-campus at the Federal Highway Administration Eastern Federal Lands Highway Division in Sterling, VA. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Registration Restrictions:
Required Prerequisites: ((CEIE 310[C], 310[XS] or L310) and (CEIE 360[C] or 360[XS])).
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Enrollment limited to students with a class of Senior Plus or Senior.

Enrollment is limited to students with a major in Civil and Infrastructure Engr.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Laboratory, Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 403: *Experimental Methods in Civil Engineering.* 3 credits.
Surveys common testing and laboratory experimental methods that civil engineers encounter in their professional practice and in research settings. Students fabricate specimens of civil engineering materials and conduct experiments in the following laboratories at the Federal Highway Administration's Turner-Fairbank Highway Research Center: Concrete and Steel Materials, Structures, Hydraulics, Geotechnical, and Asphalt. Notes: Course meets off-campus at the Federal Highway Administration's Turner-Fairbank Highway Research Center in McLean, VA. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Registration Restrictions:
Required Prerequisites: (CEIE 310[C] or 310[XS]).
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Enrollment limited to students with a class of Senior Plus or Senior.

Enrollment is limited to students with a major in Civil and Infrastructure Engr.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Laboratory, Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 409: *Professional Practice and Management in Engineering.* 1 credit.
This course instills professional ethics and management principles and prepares students for leadership roles in practice. Topics include code of ethics related to the public, clients, contractors, suppliers, employers, agreements, contracts, competitive bidding, the engineering profession, conflict of interest, legal responsibilities and case law; case studies in professional ethics; professional licensure; engineering vs. engineering management; personal development: managing cultural norms, time management, career and grad school, continuing education; public policy considerations in engineering practice; practical considerations in project management; effective communications with employers, employees, contractors, and clients; marketing, competitive bidding and project selection; conflict resolution; and managing a small business. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Registration Restrictions:
Enrollment limited to students with a class of Junior Plus, Junior, Senior Plus or Senior.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 412: *Structural Steel Design.* 3 credits.
Covers analysis and design of structural steel members including tension members, compression members, bolted and welded connections, columns, beams, and beam-columns. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Registration Restrictions:
Required Prerequisites: (CEIE 311[C], L311 or 311[XS]).
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 413: *Reinforced Concrete Design.* 3 credits.
Covers analysis and design of reinforced concrete members including beams, columns, slabs and footings; sizing of structural members for flexure and shear; determining serviceability limits; detailing reinforcing steel bars. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Registration Restrictions:
Required Prerequisites: (CEIE 311[C], L311 or 311[XS]).
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 414: *Structural Modeling for Engineers.* 3 credits.
This course provides an introduction to the computer modeling tools that underpin modern structural engineering practice: finite element analysis. Emphasis a combination of theory and practical experience with modeling software. Modeling concepts and the assumptions that engineers must make while building finite element models will be discussed. Topics include applications from structural analysis, structural design, and dynamic vibration analysis. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Recommended Prerequisite: CEIE 311.

Registration Restrictions:
Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 432: *Foundation Design.* 3 credits.
Introduction to various principles and practices of geotechnical engineering including estimation of soil properties using in-situ tests, laboratory tests, and correlations. Course includes study of earth pressure theories as applied to the design of retaining walls, anchored bulkheads, and excavation bracing. Additional topics Include retaining wall stability, bearing capacity and settlement of shallow foundations on sands and clays and design considerations and capacity analysis of deep foundations. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Registration Restrictions:
Required Prerequisites: (CEIE 305[C], 331[C], 331[XS] or L331) or ((CEIE 332[C] and 333[C])).
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 435: *Engineering Geology.* 3 credits.
Introduction to formation and occurrence of earth materials: rock and soil; weathering processes, geomorphology, structural geology, interpreting topographic and geologic maps; field investigation fundamentals, field engineering properties of soil and rock; standards and terminology; rock mass engineering classification systems; subsurface water control; rock as a construction material; special case studies in foundations, such as sinkholes, waste impoundments, dam failures, earth spillway performance. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Registration Restrictions:
Required Prerequisites: (CEIE 305[C], 331[C], 331[XS] or L331) or ((CEIE 332[C] and 333[C])).
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 440: *Water Supply and Distribution.* 3 credits.
Analysis and design of public water supplies. Topics include: water supply evaluation; water quality; demand projections; hydraulic analysis of water distribution systems including line sizing, fire protection, pumps, valves, and storage; surge analysis; water modeling; concepts in management, business, and public policy of public water supplies; and federal, state, and local government laws and regulations related to public water systems. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Registration Restrictions:
Required Prerequisites: (CEIE 340[C], 340[XS] or U340).
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 441: *Engineering for Climate Adaptation.* 3 credits.
This course introduces students to the concept of climate adaptation and to engineering solutions to reduce the vulnerability and increase the resiliency of the built environment and communities. The course covers current challenges in water resources engineering due to global changes, including the intensification of hydroclimatic hazards and their frequency. Students will be exposed to novel methods and analysis tools to incorporate climate change impacts into water resources engineering design. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Registration Restrictions:
Required Prerequisite: CEIE 340[C].
[C] Requires minimum grade of C.

Students cannot enroll who have a major in Exploratory, Undecided or Undeclared.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 442: *Open Channel Flow.* 3 credits.
Analysis and design of open channels. Topics include principles of open channel flow including conservation of mass, momentum and energy; flow regimes including uniform, gradually varied, rapidly varied, and unsteady flows; sediment transport; channel design; and modeling and computer applications in open channel analysis and design. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Registration Restrictions:
Required Prerequisites: (CEIE 340[C], L340 or 340[XS]).
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 444: *Water Resources Planning and Design.* 3 credits.
Concerned with effective use of water as a manageable natural resource. It assesses the impacts by various water resources development activities with economic, socio-cultural and environmental considerations. Methods for conducting tradeoff analyses among the engineered, human, and environmental aspects of projects are developed and applied in a term project. Offered by Civil, Environ & Infrastr Engr

(https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Recommended Prerequisite: C or better in CEIE 340.

Registration Restrictions:
Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 445: *Flood Hazards Engineering and Adaptation.* 3 credits.
This course explores the principles and practices of flood hazards engineering and adaptation, providing students with a comprehensive understanding of designing effective flood hazard mitigation strategies. Through the application of hydrological and hydraulic engineering concepts, the course covers the theory and application of these principles to flood hazard estimation, mapping, analysis and design. Students will engage in hands-on activities involving computational methods for planning, design, and management of flood hazards and engineering adaptation strategies. The curriculum includes the evaluation of existing flood mitigation strategies and the development of forward-looking sustainable design approaches. Upon completion, students will possess the skills necessary to design flood hazards engineering and adaptation strategies including assessing flood hazards, design mitigation strategies, and contribute to sustainable flood adaptation solutions. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Registration Restrictions:
Required Prerequisite: CEIE 340[C].
[C] Requires minimum grade of C.

Students cannot enroll who have a major in Exploratory, Undecided or Undeclared.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 450: *Environmental Engineering Systems.* 3 credits.
Introduces the concepts and applications of systems analysis in environmental engineering. Tools and methodologies of systems analysis are applied to improve the understanding and resolution of complex environmental engineering problems related to air, soil, water quality and pollution. Scientific, engineering, political, social, legal, regulatory, medical, economic, and financial impacts of environmental engineering decisions are considered. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Specialized Designation: Green Leaf Related Course

Registration Restrictions:
Required Prerequisites: (CEIE 355[C], L355 or 355[XS]).
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 451: *Air Pollution Formation and Control.* 3 credits.
Analysis of air pollutants through the study of radical combustion processes, chemical reaction pathways, and removal of particles and gaseous pollutants from exhaust gas streams. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Registration Restrictions:
Required Prerequisite: CEIE 355[C].
[C] Requires minimum grade of C.

Students cannot enroll who have a major in Exploratory, Undecided or Undeclared.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 452: *Climate Change Engineering and Policy.* 3 credits.
This class will provide a brief introduction to the physical and chemical processes that dictate the Earth's climate and how climate change influences natural systems. The primary focus of course material will be on the climate impacts on engineered systems and how engineers interact with the climate system through mitigation and adaptation activities. Students will be introduced to enacted and proposed policy approaches to mitigate and adapt to climate change. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Recommended Prerequisite: CLIM 102

Registration Restrictions:
Required Prerequisite: CEIE 355[C].
[C] Requires minimum grade of C.

Students cannot enroll who have a major in Exploratory, Undecided or Undeclared.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 453: *Water and Wastewater Treatment Processes.* 3 credits.
Reviews unit treatment processes used in the treatment of water and wastewater systems. Topics include water quality, regulatory requirements, physical unit processes, chemical treatment processes and an introduction to biological treatment processes as applied to a range of community sizes. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Registration Restrictions:
Required Prerequisites: (CEIE 355[C], 355[XS] or L355).
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 454: *Water and Sanitation in Low-income Communities.* 3 credits.
Introduction to challenges and opportunities associated with achieving universal access to clean water and sanitation. Topics include engineering of sustainable water supplies and sanitation services in low-income communities; household water treatment and on-site sanitation technologies; public health and socioeconomic benefits of water and sanitation; economics and financing; community participation and the role of NGOs; water insecurity in high-income countries. Students will read and discuss primary literature and conduct individual and group research projects to identify challenges and opportunities for expanding access to water and sanitation in specific communities. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Registration Restrictions:
Required Prerequisites: (CEIE 355[C], 355[XS] or L355).
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 457: *Remote Sensing in Civil Engineering.* 3 credits.
This course provides an introduction to the fundamentals of remote sensing. It will focus on how remote sensing data are acquired, displayed, restored, enhanced, and analyzed. The course will be taught with an emphasis on remote sensing techniques as a tool for engineering practices, such as regional planning, site investigation, terrain mapping, urban infrastructure development, water resources engineering, and flood monitoring. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Recommended Prerequisite: C or better in CEIE 355.

Registration Restrictions:
Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 461: *Traffic Engineering.* 3 credits.
Elements of traffic engineering analysis; system components of traffic operations: driver, vehicle, and roadway; traffic flow design elements including volume, density, and speed; intersection design elements including traffic control device warrants, signal timing, delay, capacity, and accident countermeasures; and terminal design elements including inflow, outflow, and circulation. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Registration Restrictions:
Required Prerequisites: (CEIE 360[C], 360[XS] or L360).
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 462: *Urban Transportation Planning.* 3 credits.
Technical and qualitative aspects of urban transportation planning process. Topics include urban travel characteristics and data collection methods; urban transportation modeling system, including land use, trip generation, trip distribution, mode choice, and trip assignment models; site traffic impact studies; environmental impacts; project and plan evaluation; and technology options for urban transport. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Registration Restrictions:
Required Prerequisites: (CEIE 360[C], 360[XS] or L360).
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 471: *Construction Administration.* 3 credits.
Examines the principals of project planning and administration using modern specification and project delivery methods. The role of the project manager as facilitator, constructability advisor, and on-site administrator is emphasized. Project risk transference, market conditions, and legal requirements are explored in the construction contract environment. Other topics include green specifications, design-build delivery, job order contracting, turnkey construction, and public-private partnerships. Appropriate for students, engineering and design professionals, project managers, contract administrators, and owners interested in the planning and administration needs of construction. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Registration Restrictions:
Required Prerequisites: (CEIE 370[C], 370[XS] or L370).
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 472: *Building Information Modeling.* 3 credits.
Virtual design and construction techniques are covered using modern 3D Building Information Modeling (BIM) software. Historical and

technological basis for virtual building and infrastructure design are presented. Design and construction coordination are emphasized using clash detection, conflict management, constructability analysis, specification mapping, and asset management. Industry supported model component databases are used with commercial software design environments for hands-on simulated design and construction projects. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Registration Restrictions:
Required Prerequisites: (CEIE 370[C], 370[XS] or L370).
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 473: *Legal Aspects of the Construction Process.* 3 credits.
This course examines the legal principles associated with the construction process. After introducing the class to general legal and project delivery concepts, the course provides an in-depth review of the rights and responsibilities of the major construction project participants. Major topics include the application of the changes and differing site conditions clauses, delay claims, termination rights, remedies for breach of contract, and dispute resolution techniques. The course will also include a review of current industry issues that have legal ramifications, such as principles of risk management, and unique contractual and legal challenges with design-build and construction management. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Registration Restrictions:
Required Prerequisites: (CEIE 370[C] or 370[XS]).
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 474: *Construction Computer Application and Informatics.* 3 credits.
This course covers various topics in construction enterprise information systems, data-driven decision support, relational databases, data manipulation, data visualization, application of data mining and machine learning techniques. The R software is used in this course. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to three attempts.
Registration Restrictions:
Required Prerequisites: (CEIE 370[C], 370[XS], CDS 130[C], 130[XS], CS 112[C], 112[XS], IT 104[C], 104[XS] or ENGR 125T) and (STAT 344[C], 344[XS], 260[C] or 260[XS]).
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 476: *Construction Cost Estimating.* 3 credits.
Overview of cost estimating and financial management in the modern construction industry. Techniques and software applications for construction take-offs, bidding, bonding, insurance, equipment ownership, material and labor costing. Additional topics include: cost recovery planning; budgeting, forecasting, acquisition, cast flow management, managerial accounting concepts, and taxes. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to three attempts.
Registration Restrictions:
Required Prerequisites: (CEIE 301[C] or 301[XS]).
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 477: *Construction Safety and Risk Management.* 3 credits.
This course will give students an overall understanding of construction safety concepts, techniques and tools, and impact of safety performance. The focus will be in the capital projects industry. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to three attempts.
Registration Restrictions:
Required Prerequisites: (STAT 344[C], 344[XS], 260[C] or 260[XS]).
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 478: *Construction Planning and Scheduling.* 3 credits.
This course will help students establish basic and advanced construction management skills with a focus on planning and scheduling of construction projects. Different procedures for construction control and developing a practical methodology appropriate for civil, environmental, and infrastructure engineering applications will be explored. An introduction to industry terminology, basic and advanced scheduling procedures, building work breakdown structures, activity identification, sequencing and logical ties, different levels schedule development using the critical path method, understanding schedule restrictions, schedule calculations, schedule resource management, and maintaining schedule updates will be covered. An emphasis will be placed on using computer-based scheduling software. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/

engineering/civil-environmental-infrastructure/). Limited to three attempts.
Registration Restrictions:
Required Prerequisites: (CEIE 370[C] or 370[XS]).
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 490: *Civil Engineering Senior Design Project I.* 1-3 credits.
This course is the first course in a two-course sequence in the Civil Engineering Program. Students will be working on civil engineering projects, integrate their acquired fundamental engineering knowledge and incorporate input from practitioner engineers from industry. Students form multidisciplinary design teams, select real-world civil engineering projects, develop preliminary design solutions, and prepare a draft technical report. Students will learn necessary computer-aided design software and become familiar with engineering codes and standards. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Mason Core: Mason Core, Mason Apex (https://catalog.gmu.edu/mason-core/)

Recommended Prerequisite: Three 4xx level technical electives.

Registration Restrictions:
Required Prerequisites: (CEIE 301[C], 301[XS] or L301) and (CEIE 311[C], 311[XS] or L311) and (CEIE 340[C], 340[XS] or L340) and (CEIE 355[C], 355[XS] or L355) and (CEIE 360[C] or 360[XS]) and (CEIE 305[C], L305, 331[C], 331[XS] or L331) and (CEIE 370[C] or 370[XS]).
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Enrollment limited to students with a class of Senior Plus or Senior.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Laboratory

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 491: *Civil Engineering Senior Design Project II.* 3 credits.
This course is the second course in a two-course sequence in the Civil Engineering Program. Students will build on the work they completed in CEIE 490. Teams will finalize design solutions, study constructability, evaluate cost, and consider the social, environmental, and sustainable impacts of their designs. Each student will demonstrate an understanding of the engineering design with an iterative, creative, decision-making process in which the basic sciences, mathematics, and engineering sciences are applied to convert resources into solutions. Student design must identify opportunities, develop requirements, perform analysis and synthesis, generate multiple solutions, evaluate solutions against requirements, considering risks, and make trade-offs, for the purpose of obtaining a high-quality solution under the given circumstances. An oral presentation, technical report, and technical drawing documenting the students' solution is required at the completion of the project. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). Limited to two attempts.
Mason Core: Mason Core, Mason Apex (https://catalog.gmu.edu/mason-core/)

Registration Restrictions:
Required Prerequisites: (CEIE 490[C] or 490[XS]).
[C] Requires minimum grade of C.
[XS] Requires minimum grade of XS.

Enrollment limited to students with a class of Senior Plus or Senior.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Laboratory

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 498: *Independent Study in Civil Engineering.* 1-3 credits.
Directed self-study of special topics of current interest. Notes: May be repeated if topics substantially differ. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May be repeated within the term.
Specialized Designation: Topic Varies

Recommended Prerequisite: Permission of the Department Chair.

Registration Restrictions:
Enrollment limited to students with a class of Junior or Senior.

Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Independent Study

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 499: *Special Topics in Civil Engineering.* 1-3 credits.
Varies with nature of topic. Topics of special interest to undergraduates. Notes: May be repeated if topics substantially differ. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May be repeated within the term.
Specialized Designation: Topic Varies

Registration Restrictions:
Students with the terminated from CEC major attribute may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Undergraduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

500 Level Courses

CEIE 501: *Sustainable Development.* 3 credits.
Introduces students to sustainable land development topics including low impact development, site resource conservation, ultra-low water design, deconstruction and materials reuse, healthy building design, green house gas reduction, zero and low energy design, and other topics related to sustainable practices in facilities and infrastructure design

and construction. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Specialized Designation: Green Leaf Focused Course

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the following colleges:

- College of Science
- Costello College of Business
- Engineering Computing
- Schar School of Policy and Gov

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 510: *Geographic Information Systems in Engineering.* 3 credits.
Introduces geographic information systems (GIS) and their application in environmental, transportation, land-use planning, and other engineering-related decision situations. Introduces methods and technologies for spatial data acquisition, specification, storage, manipulation, query, thematic analysis, presentation, and application in the design process. Introduces relationships, integration of GIS with computer-aided design and global positioning system. Hands-on projects. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Recommended Prerequisite: Knowledge of computer programming and databases or permission of instructor.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 512: *Structural Steel Design.* 3 credits.
Covers analysis and design of structural steel members including tension members, compression members, bolted and welded connections, columns, beams, and beam-columns. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Recommended Prerequisite: CEIE 311

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 513: *Reinforced Concrete Design.* 3 credits.
Covers analysis and design of reinforced concrete members including beams, columns, slabs and footings; sizing of structural members for flexure and shear; determining serviceability limits; detailing reinforcing steel bars. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Recommended Prerequisite: CEIE 311.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 524: *Introduction to Bridge Engineering.* 3 credits.
A balanced theoretical and practical insight into the art and science of bridge engineering. Various methodologies of bridge design and evaluation are investigated, including constructability reviews. Bridges of steel, reinforced concrete, and pre-stressed concrete materials are included. Short-span composites; major innovation and low cost solutions targeted at aging infrastructure. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Recommended Prerequisite: Graduate Standing in CEIE; CEIE 512 or CEIE 513 or equivalent.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 525: *Structural Evaluation and Rehabilitation.* 3 credits.
Structural condition survey and evaluation for strength and serviceability of existing structures including foundation elements; older building practices and materials; criteria for rehabilitation; retrofit techniques for change in function, loading, and seismic forces. Historic preservation issues. Repair, remediation, and structural strengthening methods and current trends. Carbon fiber external P.T. Material selection criteria, including mechanical and environmental factors. Cost/value feasibility analysis; estimating remedial construction costs; engineering oversight of rehabilitation work. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Recommended Prerequisite: Graduate Standing in CEIE.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 526: *Structural Steel Design II.* 3 credits.
Behavior, strength, and design of vertical steel structures using the LRFD approach; plate girders, composite beams, welded built-up columns, bolted and welded connections, beam-columns, and torsion; introduction to plastic analysis and its application to members and vertical structures; erection procedure and methods field inspection issues; unique properties of high strength steels. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Recommended Prerequisite: Graduate Standing in CEIE; CEIE 512 or equivalent.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 527: *Pre-stressed Concrete.* 3 credits.
Strength, behavior, analysis, and design of pre-stressed concrete members, vertical building structures, and bridges, with emphasis on pre-tensioned, precast construction, and post-tensioned construction; basics of segmental concrete bridges, cable-stayed bridges, and spliced-girder concrete bridges; continuous span theory; protection of pre- & post-tensioned systems; secondary effects. Composite Portland cement with cast-in-place topping; precast as a stay-in-place system; connection detailing; durability issues; advantages in a marine environment. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Recommended Prerequisite: Graduate Standing in CEIE; CEIE 513 or equivalent.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 531: *Earth Retaining Structures and Slope Stability.* 3 credits.
Earth pressure theory and limit equilibrium theory used in the design of temporary and permanent earth retaining structures; limit equilibrium slope stability; retaining wall design and associated construction issues of gravity walls, conventional concrete retaining walls, mechanically stabilized walls, braced and tiedback excavation support systems, and soil nailing walls; guidelines for the selection of retention method for permanent and temporary conditions. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Recommended Prerequisite: Graduate Standing in CEIE;

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 532: *Foundation Design.* 3 credits.
Introduction to various principles and practice of geotechnical engineering including estimation of soil properties using in-situ tests, laboratory tests, and correlations. Course includes the study of earth pressure theories as applied to the design of retaining walls, anchored bulkheads, and excavation bracing. Additional topics include retaining wall stability, bearing capacity and settlement of shallow foundations on sands and clays and design considerations for deep foundations. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 535: *Engineering Geology.* 3 credits.
Introduction to formation and occurrence of earth materials -rock and soil; weathering processes, geomorphology, structural geology, interpreting topographic and geologic maps; field investigation fundamentals, field engineering properties of soil and rock; standards and terminology; rock mass engineering classification systems; subsurface water control; rock as a construction material; special case studies in foundations, such as sinkholes, waste impoundments , dam failures, earth spillway performance. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Recommended Prerequisite: Graduate Standing in CEIE.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 540: *Water Supply and Distribution.* 3 credits.
Analysis and design of public water supplies. Topics include supply evaluation; water quality and quantity requirements; treatment requirements and methods; hydraulic analysis of water distribution systems including line sizing, fire protection, pumps, valves, and storage; sustainability; security; concepts in management, business, and public policy of public water systems; and federal, state, and local government laws and regulations related to public water systems. Requires laboratory, field work on selected topics. Designated a Green Leaf Course. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Specialized Designation: Green Leaf Focused Course

Recommended Prerequisite: Course in hydraulics or fluid mechanics

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 542: *Open Channel Flow.* 3 credits.
Analysis and design of open channels. Topics include principles of open channel flow including conservation of mass, momentum and energy; flow regimes including uniform, gradually varied, rapidly varied, and unsteady flows; sediment transport; channel design; modeling and computer applications in open channel analysis and design. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Recommended Prerequisite: A course in hydraulics or fluid mechanics.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 550: *Environmental Engineering Systems.* 3 credits.
Introduces the concepts and applications of systems analysis in environmental engineering. Tools and methodologies of systems analysis are applied to improve the understanding and resolution of complex environmental engineering problems related to air, soil, and water quality and pollution. Scientific, engineering, political, social, legal, regulatory, medical, economic, and financial impacts of environmental engineering decisions are considered. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Recommended Prerequisite: CEIE 355.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 551: *Air Pollution Formation and Control.* 3 credits.
Analysis of air pollutants through the study of radical combustion processes, chemical reaction pathways, and removal of particles and gaseous pollutants from exhaust gas streams. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 553: *Water and Wastewater Treatment Processes.* 3 credits.
Studies unit treatment processes used in the treatment of water and wastewater systems. Topics include water quality, regulatory requirements, physical unit processes, chemical treatment processes and an introduction to biological treatment processes as applied to a range of community sizes. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 556: *Environmental Law.* 3 credits.
Introductory course in the study of environmental laws as they pertain to urban systems infrastructure management. Reviews the National Environmental Policy Act, Clean Air Act, Clean Water Act, Safe Drinking Water Act, Resource Conservation and Recovery Act, Comprehensive Environmental Response, Compensation, and Liability Act, and other environmentally related legislation. Also reviews laws for allocation of surface and groundwater supplies, and reviews environmental law databases. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduation Deadline Extended, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 557: *Remote Monitoring Techniques for Civil Engineering Applications.* 3 credits.
This course covers the basic physics and applications of remote sensing, remote sensing systems (satellite, airborne, and ground-based), and atmospheric radiative transfer. The course focuses on remote sensing techniques as a tool for engineering practices and presents an exhaustive plethora of remote sensing applications for problem solving in civil, environmental, and infrastructure engineering. Examples include (but are not limited to) regional planning and site investigation, terrain mapping and urban infrastructure development, water resources engineering, transportation network analysis, landslide analysis, flood monitoring, and bridge inspection. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Recommended Prerequisite: Graduate standing in CEIE.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 560: *Public Transportation Systems.* 3 credits.
Analyzes public transportation systems in terms of their role in urban transportation. Topics include history of public transportation in the United States, quantitative performance attributes of different modes, analytical techniques for planning and operation, and management and administrative concepts. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Recommended Prerequisite: CEIE 360.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 561: *Traffic Engineering.* 3 credits.
Covers elements of traffic engineering analysis; system components of traffic operations: driver, vehicle, and roadway; traffic flow design elements including volume, density, and speed; intersection design elements including traffic control device warrants, signal timing, delay, capacity, and accident countermeasures; and terminal design elements including inflow, outflow, and circulation. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Recommended Prerequisite: CEIE 365.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 562: *Urban Transportation Planning.* 3 credits.
Covers technical and qualitative aspects of urban transportation planning process. Topics include urban travel characteristics and data collection methods; urban transportation modeling system, including land use, trip generation and distribution, mode choice, and trip assignment models; site traffic impact studies; environmental impacts; project and plan evaluation; and technology options for urban transport. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Recommended Prerequisite: CEIE 360.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 571: *Construction Administration.* 3 credits.
Examines the principals of project planning and administration using modern specification and project delivery techniques. The role of the project manager as facilitator, constructability advisor, and on-site administrator is emphasized. Project risk transference, market conditions, and legal requirements are explored in the construction contract environment. Other topics include green specifications, design-build delivery, job order contracting, turnkey construction, and public-private partnerships. Appropriate for students, engineering and design professionals, project managers, contract administrators, and owners interested in the planning and administration needs of construction. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the following colleges:

- College of Science
- Costello College of Business
- Engineering Computing
- Schar School of Policy and Gov

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 572: *Building Information Modeling.* 3 credits.
Virtual design and construction techniques are covered using modern 3D Building Information Modeling (BIM) software. Historical and technological basis for virtual building and infrastructure design are presented. Design and construction coordination are emphasized using clash detection, conflict management, constructability analysis, specification mapping, and asset management. Industry-supported model component databases are used with commercial software design environments for hands-on simulated design and construction projects. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 573: *Legal Aspects of the Construction Process.* 3 credits.
Examines the legal principles associated with the construction process. Introduces legal and project delivery concepts and review of the rights and responsibilities of construction project participants. Topics include the application of differing site conditions clauses, delay claims, termination rights, remedies for breach of contract, and dispute resolution techniques. Also includes review of industry legal issues, such as principles of risk management, LEED liability, and design-build contracts. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Recommended Prerequisite: Graduate Standing in CEIE.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the following colleges:

- College of Science
- Costello College of Business
- Engineering Computing
- Schar School of Policy and Gov

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 574: *Construction Computer Application and Informatics.* 3 credits.
Computer-aided information management in construction, including construction decision-support systems, data-driven decision support, relational databases, data manipulation, data visualization, and application of data mining techniques. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 575: *Design for Constructability.* 3 credits.
Systems design of structures to consider foundations, structures and constructability; foundation alternatives; structural design to simplify erection; prefabrication, modulation of structures; material handling on a construction site; crane selection and placement; temporary works. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Recommended Prerequisite: Graduate Standing in CEIE.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 576: *Construction Cost Estimating.* 3 credits.
Overview of cost estimating and financial management in the modern construction industry. Techniques and software applications for construction take-offs, bidding, bonding, insurance, equipment ownership, material and labor costing. Additional topics include: cost recovery planning; budgeting, forecasting, acquisition, cast flow management, managerial accounting concepts, and taxes. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Recommended Prerequisite: Graduate Standing in CEIE.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the following colleges:

- College of Science
- Costello College of Business
- Engineering Computing
- Schar School of Policy and Gov

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 578: *Construction Planning and Scheduling.* 3 credits.
This course will help students establish basic and advanced construction management skills with a focus on planning and scheduling of construction projects. Different procedures for construction control and developing a practical methodology appropriate for civil, environmental, and infrastructure engineering applications will be explored. An introduction to industry terminology, basic and advanced scheduling procedures, building work breakdown structures, activity identification, sequencing and logical ties, different levels schedule development using the critical path method, understanding schedule restrictions, schedule calculations, schedule resource management, and maintaining schedule updates will be covered. An emphasis will be placed on using computer-based scheduling software. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

600 Level Courses

CEIE 601: *Infrastructure Modeling.* 3 credits.
Concepts of modeling for infrastructure engineering systems. Covers deterministic and stochastic modeling, multi-objective decision-making, and solution algorithms for civil infrastructure problems. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 603: *Research Methods in Civil Engineering.* 3 credits.
Familiarizes students with the process of rigorous research in civil engineering by providing a strong background in research methods, such as critical thinking, experimental design (idea, concept, design, development), writing a scientific article, and interpretation of results (uncertainty quantification, assumptions, etc.). Introduces common quantitative methods in civil engineering research such as descriptive and inferential statistics, data assimilation, and hypothesis testing. Encourages critical thinking and collaboration among students from different civil engineering disciplines. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Recommended Prerequisite: Graduate standing in CEIE.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 605: *Risk and Uncertainty in Civil Engineering.* 3 credits.
Probability and statistics topics for analysis of infrastructure systems. Includes Bayesian decision theory, decision trees, Monte Carlo analysis, stochastic models, simulation, and economic analysis of infrastructure projects and systems. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Recommended Prerequisite: STAT 344.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 607: *Public Infrastructure Management and Finance.* 3 credits.
Current and projected outlook for managing and financing public works infrastructure including, transportation, public utilities, water and waste water facilities, energy, and public buildings; Infrastructure management including the impact of built infrastructure on the environment, tracking and improving infrastructure performance, government regulations, emerging technologies, social concerns, and the impacts of disasters; Infrastructure finance including public and private sources of capital, special financing districts, bond markets, federal and state grants, public-private partnerships, and design-build project delivery. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the following colleges:

- College of Science
- Costello College of Business
- Engineering Computing
- Schar School of Policy and Gov

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 611: *Structural Analysis II.* 3 credits.
Application of the stiffness method in planar trusses, beams, planar frames, curved beams, and three-dimensional structures; Introduction to non-linear structural analysis with emphasis on geometric non-linearity. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 612: *Mechanics of Materials II.* 3 credits.
Covers the foundations of structural modeling and theories of elasticity. Topics include: multidimensional theories of stress and strain, governing equations of elasticity, numerical solution techniques, material failure criteria, basics of nonlinear analysis. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 613: *Structural Dynamics.* 3 credits.
This course covers the fundamental principles necessary to analyze the responses of structures subjected to dynamic loads such as blast, earthquake, rotating machinery, etc. Idealized linear structural models subjected to free vibrations, harmonic vibrations, and impulsive loadings are presented. Practical applications of structural dynamics for solving simplified problems in blast and earthquake engineering are included. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Recommended Prerequisite: Differential Equations.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 619: *Special Topics in Structural Engineering.* 0-3 credits.
Advanced topics in recently developed areas of structural engineering. May be repeated for credit when topics vary. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May be repeated within the term.

Specialized Designation: Topic Varies

Recommended Prerequisite: Graduate standing in CEIE or permission of the instructor.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 620: *Intelligent Systems in Civil Engineering.* 3 credits.
Covers autonomous systems in civil engineering across CEIE sub-disciplines. Topics include: sensing & instrumentation, data analytics, and machine learning applications. Laboratory exercises with sensing and data acquisition systems, as well as a student-driven class project. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 623: *Reinforced Concrete Design II.* 3 credits.
Covers the behavior, analysis and design of two-way reinforced concrete slabs; design of long columns including slenderness effects; structural design of isolated footings, combined footings and pile caps; design of deep beams using the strut-and-tie models; introduction bearing, retaining and shear wall designs. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Recommended Prerequisite: Reinforced Concrete Design.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 631: *Soil Dynamics.* 3 credits.
Introduces principles for the design and construction of earthquake resistant civil infrastructure with a focus on the behavior of soils under dynamic loading conditions. Covers geology and seismology relevant to the design of foundations, retaining walls, slopes, embankments, tunnels, and maritime structures. Includes field and laboratory methods for determining dynamic soil properties. Soil liquefaction analysis and mitigation are also addressed. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 632: *Soil Remediation.* 3 credits.
This course provides an in-depth exploration of soil remediation techniques and strategies aimed at addressing various types of soil contamination. Topics include the principles, technologies, and methodologies involved in remediating polluted soils. The course includes both theoretical concepts and practical applications, with a focus on case studies and real-world examples. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 633: *Designing with Geosynthetics.* 3 credits.
This course provides an overview of geosynthetics, including behavior, applications, and properties. Design methods using geotextiles, geogrids, geonets, geomembranes, and geosynthetic clay liners are emphasized. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 634: *Geoenvironmental Design.* 3 credits.
This course covers the fundamental principles regarding waste geotechnics, including the design of landfill liners/covers, fate of pollutant transport in groundwater, transport processes, modeling techniques for flow and transport, waste settlement, and groundwater remediation technologies such as biodegradation of waste. The class requires students to study journal papers as supplemental material to the lectures. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Recommended Prerequisite: Graduate Standing in CEIE.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 635: *Advanced Soil Mechanics.* 3 credits.
Consolidation of soil: primary and secondary; and rate. Soil strength in the framework of Critical State Soil Mechanics: normally consolidated, lightly and heavily overconsolidated, drained and undrained, elastic and plastic deformation. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 636: *Sources of Geotechnical Data.* 3 credits.
Resources for conducting desk top studies; tools for field investigations; subsurface investigations (options and selection of techniques); laboratory testing of soil and rock; accepted testing procedures; typical values; empirical relationships between properties and testing techniques; risk and uncertainty; use of lab testing, insitu strength testing, and empirical methods in design; identifying slickensides. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Recommended Prerequisite: Graduate Standing in CEIE.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 637: *Tunneling and Ground Improvement.* 3 credits.
Fundamentals of underground construction, design considerations, risk management, and various tunneling techniques including tunnels, caverns, and cut and cover construction. Densification-based and reinforcement-based ground improvement techniques and the basics of designing various systems of each. Specific techniques anticipated to be covered include surcharging, grouting, densification, and rigid inclusions. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Recommended Prerequisite: Graduate Standing in CEIE.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 638: *Advanced Foundation Design.* 3 credits.
Design of shallow and deep foundations for civil engineering structures, including time rate of consolidation settlement, stress distribution, elastic settlement, and bearing capacity. Driven piles and drilled shafts subjected to axial and lateral loading, both single and group action. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.

Recommended Prerequisite: Graduate Standing in CEIE.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 639: *Special Topics in Geotechnical Engineering.* 1-3 credits.
Advanced topics in recently developed areas of geotechnical engineering. May be repeated for credit when topics vary. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May be repeated within the term.
Specialized Designation: Topic Varies

Recommended Prerequisite: Graduate standing in CEIE or permission of the instructor.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 641: *Water Resources Engineering I: Principles and Practice.* 3 credits.
Introduction to the principles of hydrology and hydraulics and their application to the planning, design and management of modern water resources. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Recommended Prerequisite: Graduate standing in CEIE; CEIE 340 or equivalent.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 643: *Coastal Flood Hazards.* 3 credits.
Introduction to the theory and practice of coastal flooding and hazards engineering. Topics include the theory of hurricane storm surges, tides, coastal hydrodynamics, waves and coastal processes. Use of the Surface Water Modeling System (SMS) and the Advanced Circulation Model (ADCIRC) for coastal flooding analysis. Introduction to High Performance Computing (HPC) modeling of hurricane storm surge. Introduction to Geographic Information Systems (GIS) applications to support coastal flood modeling and hazard analysis. Applications of coastal engineering to support coastal flood mapping and hazard prevention. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Recommended Prerequisite: Graduate Standing in CEIE.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 644: *Groundwater Systems Modeling.* 3 credits.
Introduces groundwater hydrology and modeling, including quantity and quality aspects. Topics include characterization of subsurface regime; well hydraulics; consideration of two-dimensional steady and unsteady-state flows; exploration of modeling approaches; simulation and optimization modeling; contaminant transport; parameter estimation; and design of systems to control groundwater quantity and quality. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 645: *Flood Hazards Engineering and Adaptation.* 3 credits.
Introduction to the principles of flood hazards engineering. Theory and practice of the application of hydrology and hydraulics to flood hazards delineation. Theory and practice of the application of geospatial analyses to support flood hazards modeling. Application of computational methods to support planning, design and management of flood hazards. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Recommended Prerequisite: Graduate standing in CEIE and CEIE 340 and CEIE 340 or equivalent.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 649: *Special Topics in Water Resources Engineering.* 0-3 credits.
Advanced topics in recently developed areas of water resources engineering. May be repeated for credit when topics vary. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May be repeated within the term.
Specialized Designation: Topic Varies

Recommended Prerequisite: Graduate standing in CEIE or permission of the instructor.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 657: *Environmental Engineering Microbiology.* 3 credits.
Addresses the fundamental aspects of microbial physiology and ecology and their application to environmental engineering processes. Specific topics include cell structure and function, energetics, metabolism, enzyme and growth kinetics, microbial/environmental interactions (e.g. interactions with organic pollutants), biogeochemical cycles, and an introduction to engineering applications including bioremediation, wastewater treatment, biosensors and microbial fuel cells. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 658: *Water Quality.* 3 credits.
This course addresses the physical, chemical and biological principles that define water quality. Mathematical and chemical models are formulated and employed to predict fate and transport of contaminants in both surface and groundwater. Laboratory and field-work are required. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 659: *Hazardous Waste.* 3 credits.
Physical, chemical and biological properties of hazardous waste; abiotic and biotic transformation of hazardous wastes and their fate in the environment; design of remediation schemes including incineration, landfill, bioremediation and other physical and chemical stabilization processes; principles of risk assessment to select and optimize hazardous waste treatment; methods and strategies for hazardous waste reduction. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 662: *Travel Demand Modeling.* 3 credits.
Covers elements of Travel Demand Modeling at considerable detail. Design and execution of travel surveys; analysis of survey data; economic and demographic data and analysis; development of classification, regression and discrete choice models for four-step and activity based travel demand models; spatial analysis of data; matrix methods; validation and calibration of models; traffic and transit assignment methods and their application; select-link anal sis. Hands-on modeling assignments. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 663: *Intelligent Transportation Systems.* 3 credits.
Advanced transportation system operations and safety through the use of wireless and wireline communications; integrated transportation systems; in-vehicle technologies; industry standards; and systems architecture. Provides skills to apply advanced technologies to transportation systems to improve operational and safety performance. Provides nontraditional tools to address issues of congestion and improved safety performance. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Recommended Prerequisite: CEIE 561 or 562.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 664: *Transportation Engineering and the Environment.* 3 credits.
Introduction to transportation and air quality; Clean Air Act; greenhouse gases, climate change, and modeling for greenhouse gases; travel activity; The NEPA process for transportation projects; road transportation and noise; noise abatement. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 665: *Travel Survey Methods and Data Analysis.* 3 credits.
Covers the concept and practice of travel survey methods; national household travel survey; Census transportation survey and products; travel diary based, roadside, mail-in and web-based and GPS-based travel surveys; longitudinal vs. cross-sectional surveys; stated-preference survey; interactive and adaptive survey method; transit survey methods; special generator surveys; sampling approach and representativeness analysis; econometric data analysis; panel data; self-selection issues; other data mining methods; data security, privacy, IRB process, and ethics. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 667: *Multi-modal Transportation Systems.* 3 credits.
Topical coverage of freight and logistics; non-motorized transportation considerations; and public transit planning. Freight topics include demand and supply modeling concepts; freight flow data sources; and truck size and weight policies. Bicycle and pedestrian planning considering traveler response to facility and policy improvements and identifying common resources for addressing non-motorized project concerns. Public transportation planning coverage including mass transit technology typologies, corridor planning and operations concepts, and finance and public policy issues, including environmental justice. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 668: *Transportation Economics.* 3 credits.
Application of micro- and macro-economic theories to transportation system analysis; interaction between transportation system, land use, and regional economics; mobility, accessibility, and system reliability; market equilibrium; pricing, willingness to pay, and welfare analysis; cost benefit analysis; project finance. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 669: *Special Topics in Transportation Engineering.* 0-3 credits.
Advanced topics in recently developed areas of transportation engineering. May be repeated for credit when topics vary. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May be repeated within the term.

Specialized Designation: Topic Varies

Recommended Prerequisite: Graduate standing in CEIE or permission of the instructor.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 677: *Construction Simulation.* 3 credits.
Overview of production management in construction. Techniques for modeling construction operations, design of efficient processes, measurement and improvement of productivity. Computer simulation techniques for modeling and analysis. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Recommended Prerequisite: Graduate Standing in CEIE.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 678: *Infrastructure Asset Management.* 3 credits.
Provides the principles of infrastructure asset management, including performance management, risk management, financial planning, state-of-the-practice in implementing asset management systems for infrastructure owners, and challenges in development and implementation of asset management practices for public and private sector infrastructure owners. Introduces emerging technology applications in asset management to prepare the next generation of professionals for the marketplace of the future. Investigates how existing infrastructure assets are preserved, repaired and renewed, by shifting focus from creating new and additional capacity to maximizing the functionality of existing assets. Engineering, financial and investment planning, and management consulting principles are combined in a strategic and systematic process that focuses on effective operation, maintenance, upgrade, and expansion of physical assets through a whole-life approach. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 679: *Special Topics in Construction Management.* 3 credits.
Advanced topics in recently developed areas of construction management. May be repeated for credit when topics vary. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May be repeated within the term.
Specialized Designation: Topic Varies

Recommended Prerequisite: Graduate standing in CEIE or permission of the instructor.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 683: *Water and Wastewater Systems Security.* 3 credits.
Examines overall security of water and wastewater systems. Covers theory and methods to define water and wastewater infrastructure as physical and organizational systems. Explores concepts of infrastructure systems security; identifies actors, interactions in organizational infrastructure, and threats to water and wastewater infrastructure; describes behavior of physical and organizational infrastructures under stress; examines history of threats or attacks against water and wastewater systems; and explores evolution of design, operations, and maintenance paradigms in response to changes in threats. Covers proactive responses to security threats through vulnerability assessments, and models of organizational and physical infrastructure system. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Recommended Prerequisite: BS in Civil Engineering or CEIE 440 and CEIE 455.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 686: *Transportation System Security and Safety.* 3 credits.
Focuses on critical transportation systems infrastructure and operations, and technologies for predicting and managing damage and disruptions caused by potential threats, including natural and technological disasters and terrorist threats. Includes asset management, methodologies for assessing vulnerabilities, potential impact of damage and disruption, applying state-of-the-art technologies and R&D processes for harnessing best analysis methods, and technologies for hardening transportation infrastructure systems. Includes sensing and surveillance using satellite and aerial remote sensing imagery, application of GIS and spatial information technologies, information and communication, intelligent transportation systems, hardening systems, and making intelligent choices for implementing technology advances to transportation security and safety. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Recommended Prerequisite: BS in Engineering, or permission of instructor.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 690: *Topics in Civil Engineering.* 3 credits.
Topics not covered in the regular civil engineering offerings. Notes: Course content may vary each semester. Course may be repeated with change in topic. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May be repeated within the term.
Specialized Designation: Green Leaf Related Course, Topic Varies

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

700 Level Courses

CEIE 742: *Water Resources Engineering II: Water Resource Systems.* 3 credits.
Introduces concepts, applications, and tools of systems analysis for water resources planning, management, and design. Problems including river basin planning, real-time hydrosystem operations, water quality management, capacity expansion, urban drainage network design, and sanitary sewer design used to illustrate applications of systems analysis. Tools include optimization and simulation modeling and knowledge-based systems. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Recommended Prerequisite: Graduate Standing in CEIE; CEIE641 or equivalent.

Registration Restrictions:
Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 762: *Network Models for Transportation Planning.* 3 credits.
Covers network models for transportation systems analysis - theory, mathematical structure, and applications of equilibrium, iterative, incremental, dynamic and stochastic equilibrium models. Also covers data structures and heuristic methods for computer implementation of various algorithms such as shortest path and direction search algorithms; specialty network topics such as tracking and prohibition of turn movements, k-shortest path algorithms and select-link analysis. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Recommended Prerequisite: CEIE 562 or 660; CEIE 601.

Registration Restrictions:
Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 763: *Discrete Choice Analysis in Transportation.* 3 credits.
Utility theory and individual choice behavior; Binary choice model; Multinomial choice model; Characteristics of Probit and Logit models; Aggregate forecasting techniques; Travel survey and sampling; Test and choice of model structure; Correlation and nested Logit Model, Advanced models and estimation techniques; Travel, route choice and car ownership models. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Registration Restrictions:
Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 764: *Transportation Network Algorithms.* 3 credits.
This course focuses on network optimization algorithms for transportation and logistics systems. The application of these techniques to the determination of optimal routes and tours for various transportation and logistics applications is stressed. In addition to introducing a wide variety of network-related problems and existing techniques for solving a number of these problems, an important goal of the course is to help the class participants develop skills in creating and evaluating new algorithms and heuristics. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate or Non-Degree.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 767: *Traffic Engineering Modeling and Analysis.* 3 credits.
Covers fundamentals of traffic flow theory; shock-wave analysis; queuing theory; macroscopic traffic flow models on freeway and arterials; fundamentals of traffic simulation; car following models; network analysis based on traffic simulation models; and developing skills to select most appropriate model for given scenarios. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Recommended Prerequisite: CEIE 561.

Recommended Corequisite: CEIE 601.

Registration Restrictions:
Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 795: *Civil and Infrastructure Engineering Seminar.* 0 credits.
Invited speakers, faculty, and CEIE graduate students lecture on current topics and research. Fulfills seminar requirement for MS in civil and infrastructure engineering. Notes: Students must enroll in CEIE 795 each semester (fall and spring) for the duration of their MS studies. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May be repeated within the degree.
Registration Restrictions:
Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Seminar

Grading:
This course is graded on the Satisfactory/No Credit scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 796: *Directed Reading.* 1-3 credits.
Reading on specific topic under direction of faculty member. Notes: May be repeated with change in topic. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May be repeated within the degree.
Specialized Designation: Topic Varies

Recommended Prerequisite: Graduate standing and permission of instructor.

Registration Restrictions:
Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Independent Study

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 798: *Research Project in Civil Engineering.* 3 credits.
Analyzes and investigates contemporary problem in civil, environmental, and infrastructure engineering. Requires prior approval by faculty member who supervises student's work. Notes: Written report also required. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Recommended Corequisite: CEIE 795.

Registration Restrictions:
Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Thesis

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 799: *Master's Thesis.* 1-6 credits.
Research project chosen and completed under guidance of graduate faculty member that results in technical report acceptable to three-faculty-member committee, and an oral defense. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May be repeated within the degree.
Recommended Prerequisite: 18 credits of graduate-level course work and permission of instructor.

Registration Restrictions:
Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Thesis

Grading:
This course is graded on the Satisfactory/No Credit scale. (https://catalog.gmu.edu/policies/academic/grading/)

800 Level Courses

CEIE 800: *Civil, Environmental, and Infrastructure Engineering Colloquium.* 1 credit.
Seminar series required of Civil and Infrastructure PhD students. Features variety of speakers from universities, government, and private sectors. Topics include civil engineering technologies, research advancements, and policies. Doctoral students take 2 credits of CEIE 800 and make a presentation of their dissertation research at the seminar. No more than 1 credit per semester may be taken. Students eligible to register upon successful completion of qualifying exams. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May be repeated within the degree for a maximum 2 credits.
Registration Restrictions:
Enrollment limited to students in the EC-PHD-CEIE program.

Enrollment is limited to Graduate level students.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Seminar

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 890: *Special Topics in Urban Transportation.* 3 credits.
Includes traffic safety analysis, simulation in transportation, intelligent transportation systems, advanced public transportation systems, congestion and travel demand management, geographic information systems and information technology, and innovative refinancing and

public-private partnerships. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May be repeated within the degree for a maximum 6 credits.
Specialized Designation: Topic Varies

Recommended Prerequisite: CEIE 560 and 660 or equivalent; or permission of instructor.

Registration Restrictions:
Enrollment is limited to Graduate level students.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 892: *Special Topics in Environmental and Water Resource Systems Engineering.* 3 credits.
Possible topics include studies in waste minimization; pollution prevention; hazardous waste management; wastewater management; air pollution control; solid waste management; environmental decision making; sustainability; water resource and environmental economics; wetlands management, design and construction; groundwater contamination modeling; stochastic hydrology; river basin planning and management; and water quality modeling. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May be repeated within the degree for a maximum 6 credits.
Specialized Designation: Green Leaf Focused Course, Topic Varies

Recommended Prerequisite: CEIE 601

Registration Restrictions:
Enrollment is limited to Graduate level students.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Lecture

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 894: *Design and Inventive Engineering.* 3 credits.
Topics include Fundamentals: successful intelligence and creative intelligence, creative class, the Medici Effect, the Renaissance Man and Da Vinci's Seven Principles, engineering creativity; Design Engineering: system designing and architecting, designing as search, evolutionary designing, constraint search, constructive induction, Axiomatic and Inferential Design Theories; Inventive Engineering: Brainstorming, Synectics, Morphological Analysis, TRIZ, Visual Thinking, Inventive Design in Practice; Project Presentations. Notes: This is transdisciplinary course focused on creativity in engineering and science. Open to all graduate students in the Volgenau School of IT and Engineering; graduate students from other schools are encouraged to register with the instructor's permission. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit.
Registration Restrictions:
Enrollment is limited to Graduate level students.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Seminar

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 896: *Civil Engineering Research Topics.* 3 credits.
Reading on specific topic under direction of faculty member. May be repeated with change in topic. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May be repeated within the degree for a maximum 6 credits.
Specialized Designation: Topic Varies

Recommended Prerequisite: Admission into CEIE PhD program, or permission of instructor.

Registration Restrictions:
Enrollment is limited to Graduate level students.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Independent Study

Grading:
This course is graded on the Graduate Regular scale. (https://catalog.gmu.edu/policies/academic/grading/)

900 Level Courses

CEIE 990: *Civil and Infrastructure Dissertation Topic Presentation.* 1 credit.
Opportunity for PhD students to present research proposal for critique. Covers presentation of research topic for PhD in Civil and Infrastructure Engineering. Students complete dissertation research proposal. May be repeated with change in topic, but degree credit is given only once. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May not be repeated for credit. Equivalent to STAT 990.
Recommended Prerequisite: Graduate Standing; completion of all course work required for PhD in Civil and Infrastructure Engineering or permission of instructor.

Registration Restrictions:
Enrollment limited to students in the EC-PHD-CEIE program.

Enrollment is limited to Graduate level students.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Research

Grading:
This course is graded on the Satisfactory/No Credit scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 998: *Doctoral Dissertation Proposal.* 1-12 credits.
Work on research proposal that forms basis for doctoral dissertation. May be repeated for credit. Notes: No more than 24 credits of CEIE 998 and 999 may be applied to doctoral degree requirements. Offered by

Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May be repeated within the degree.
Registration Restrictions:
Enrollment is limited to Graduate level students.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Dissertation

Grading:
This course is graded on the Satisfactory/No Credit scale. (https://catalog.gmu.edu/policies/academic/grading/)

CEIE 999: *Doctoral Dissertation.* 1-12 credits.
Formal record of commitment to doctoral dissertation research under direction of faculty member in civil engineering and infrastructure engineering. May be repeated in the degree, but no more than 24 combined credits of CEIE 998 and CEIE 999 may be applied to the doctoral degree requirements. Offered by Civil, Environ & Infrastr Engr (https://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/civil-environmental-infrastructure/). May be repeated within the degree.
Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy.

Enrollment is limited to Graduate level students.

Enrollment limited to students in the College of Science, Engineering Computing or Schar School of Policy and Gov colleges.

Schedule Type: Dissertation

Grading:
This course is graded on the Satisfactory/No Credit scale. (https://catalog.gmu.edu/policies/academic/grading/)