

# ENVIRONMENTAL ENGINEERING (EVEG)

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## Faculty

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## Mission Statement

Bucknell University's Environmental Engineering program strives to provide the best undergraduate environmental engineering education possible within a four-year curriculum. The Environmental Engineering degree program seeks to prepare our students to become responsible, contributing members of society and to continue to develop personally and professionally after graduation. The program is designed to ensure that our students are qualified to enter and succeed in the environmental engineering profession, enroll in graduate programs in environmental engineering, or enter related industrial and business professions. Primary emphasis is placed on educational excellence achieved through a coherent and comprehensive curriculum, outstanding teaching, extensive student-faculty interaction, small class sizes, substantial laboratory and field trip experiences, and faculty scholarship that often directly involves students.

## Program Goals

The Environmental Engineering programs seek to prepare students to be successful professionals recognized for their:

1. critical thinking and problem-solving based on a fundamental knowledge of humanities, social sciences, mathematics, science, engineering sciences, and a broad range of environmental engineering technical areas;
2. consideration of global and societal concerns, ethics and sustainability when making engineering decisions;
3. leadership and effective communication;
4. civil engagement and contributions to society; and
5. pursuit of lifelong learning and professional development.

## Program Educational Objectives

- Graduates will attain a record of engagement in environmental engineering or other fields that require analytical and/or professional abilities.
- Graduates will attain a record of continuing professional development.
- Graduates will attain a record of contribution to their fields, professions or society.

## Student Outcomes

Graduates of the program are expected to demonstrate the following learning outcomes, which reflect ABET accreditation criteria.

1. An ability to identify, formulate and solve complex engineering problems by applying principles of engineering, science and mathematics.
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety and welfare, as well as global, cultural, social, environmental and economic factors.
3. An ability to communicate effectively with a range of audiences.
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental and societal contexts.
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks and meet objectives.
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. An ability to acquire and apply new knowledge as needed using appropriate learning strategies.

The Environmental Engineering program at Bucknell University is accredited by the Engineering Accreditation Commission of ABET, [www.abet.org](https://www.abet.org/) (<https://www.abet.org/>).

## Bachelor of Science in Environmental Engineering

The **Bachelor of Science** in Environmental Engineering requirements are:

### First Year

| First Semester | Credits  | Second Semester | Credits    |
|----------------|----------|-----------------|------------|
| ENGR 100       |          | 1 CEEG 242      | 1          |
| MATH 201       |          | 1 ENGR 101      | .5         |
| PHYS 211       |          | 1 ENGR 229      | 1          |
| W1 Course      |          | 1 GEOL 250      | 1          |
|                |          | MATH 202        | 1          |
|                | <b>4</b> |                 | <b>4.5</b> |

### Sophomore

| First Semester | Credits    | Second Semester              | Credits    |
|----------------|------------|------------------------------|------------|
| CEEG 340       |            | 1 CEEG 440                   | 1          |
| CHEM 203       |            | 1 ENGR 222                   | 1          |
| MATH 211       |            | 1 ENST 208                   | 1          |
| ENGR 226       |            | .5 MATH 222                  | .5         |
| ECON 101       |            | 1 Sustainability Perspective | 1          |
|                | <b>4.5</b> |                              | <b>4.5</b> |

### Junior

| First Semester | Credits  | Second Semester              | Credits  |
|----------------|----------|------------------------------|----------|
| CEEG 290       |          | .5 Two Technical Electives   | 2        |
| CEEG 320       |          | 1 Sustainability Perspective | 1        |
| CEEG 350       |          | 1 Elective                   | 1        |
| CEEG 445       |          | 1 CEEG 390                   | 0        |
| ENGR 212       |          | .5                           |          |
|                | <b>4</b> |                              | <b>4</b> |

### Senior

| First Semester             | Credits  | Second Semester | Credits    |
|----------------------------|----------|-----------------|------------|
| CEEG 441                   |          | 1 CEEG 443      | 1          |
| CEEG 492                   |          | 1 CEEG 444      | 1          |
| Technical Elective         |          | 1 CEEG 493      | .5         |
| Sustainability Perspective |          | 1 Two Electives | 2          |
|                            | <b>4</b> |                 | <b>4.5</b> |

### Total Credits: 34

- Four sustainability perspectives electives from approved list, including ECON 101.
- Three unrestricted electives. These can be used to pursue additional interests or further develop expertise in a specific area.
- Three technical electives, selected from a preapproved list of courses.
- Each student must meet the general education component, including the requirement for global and societal perspectives, through the selection of courses within the sustainability perspectives lists and the three unrestricted electives.
- Three courses in each student's program must fulfill the University writing requirement that includes a W1 course taken in the first semester and two subsequent W2 courses.
- Fulfillment of the MATH requirement can be achieved by completion of the five specified MATH courses at Bucknell University, Advanced Placement credit, credit by examination at Bucknell, or approved transfer credit from another institution. Other MATH courses may fulfill this requirement, subject to approval by the Department of Civil & Environmental Engineering.

Graduates of the program are expected to demonstrate the following learning outcomes, which reflect ABET accreditation criteria.

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. An ability to communicate effectively with a range of audiences.

4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

## Courses

### **CEEG 242. Sustainability Principles for Engineers. 1 Credit.**

**Offered Spring Semester Only; Lecture hours:4**

An introduction to concepts for the application of sustainable engineering principles. Topics include sustainability concepts and definitions, life-cycle assessment, engineering and ecological economics, biogeochemical cycles, embedded resources, climate science, indicators of social sustainability, and systems thinking. Preference given to First and Second Year Civil Environmental Engineering Students.

### **CEEG 280. Special Topics in Civil Engineering. .5-1 Credits.**

**Offered Either Fall or Spring; Lecture hours:Varies**

Individual projects in laboratory work, design, or library studies, depending upon the nature of the problem selected. Prerequisite: permission of the instructor.

### **CEEG 290. Engineering Economics & Project Management. .5 Credits.**

**Offered Fall Semester Only; Lecture hours:1,Lab:2**

Fundamental topics underlining civil and environmental engineering design and management over the project life cycle, including engineering economy, sustainable design, project management and leadership, engineering ethics and the importance of professional licensure. Prerequisites: open to civil or environmental engineering majors. All others by permission of the instructor.

### **CEEG 2NT. Civil and Environmental Non-traditional Study. .25-4 Credits.**

**Offered Occasionally; Lecture hours:Varies**

Non-traditional study in civil engineering.

### **CEEG 300. Introduction to Structural Engineering. 1 Credit.**

**Offered Spring Semester Only; Lecture hours:3,Lab:2**

Introduction to behavior, analysis and design of structures; including design criteria, loads, modeling of structural systems, design with various material types (e.g. steel, concrete, timber, masonry). Discussion of the design process, and societal/global context of structural design. Case studies used throughout the course. Prerequisite: ENGR 239.

### **CEEG 320. Water Resources Engineering. 1 Credit.**

**Offered Fall Semester Only; Lecture hours:3,Lab:2**

Planning, design, and operation of water resources projects with emphasis on hydrology, hydraulic structures, and open and closed conduits; applications in stormwater management and water supply. Prerequisite: ENGR 222.

### **CEEG 330. Introduction to Transportation. 1 Credit.**

**Offered Spring Semester Only; Lecture hours:3,Lab:2**

Transportation systems, operations, planning, and design for highways and other modes; sustainability, safety, social, and economic issues; traffic studies in the local community.

### **CEEG 340. Environmental Engineering. 1 Credit.**

**Offered Fall Semester Only; Lecture hours:3,Lab:2**

Introduction to fundamentals of environmental engineering and science including chemistry, microbiology, mass balance, and reactor theory. Application of concepts to environmental engineering includes water quality, water and waste-water treatment, solid and hazardous waste, air pollution, greenhouse gases and climate change. Includes hands-on lab. Corequisite: CHEM 201 or CHEM 203.

### **CEEG 350. Geotechnical Engineering I. 1 Credit.**

**Offered Fall Semester Only; Lecture hours:3,Lab:2**

Origin, composition, structure, and properties of soils. Identification, classification, strength, permeability, and compressibility characteristics. Introduction to foundation engineering. Laboratory determination of soil properties. Prerequisites: ENGR 222 and ENGR 229 or permission of the instructor.

### **CEEG 380. Special Topics in Civil Engineering. .5-1 Credits.**

**Offered Either Fall or Spring; Lecture hours:Varies**

Individual projects in laboratory work, design, or library studies, depending upon the nature of the problem selected. Prerequisite: permission of the instructor.

**CEEG 390. Civil & Environmental Engineering Seminar. 0 Credits.**

**Offered Spring Semester Only; Lecture hours:2; Repeatable**

A weekly seminar for all civil engineering majors. Presentations by practicing engineers and others covering multiple sub-disciplines of civil engineering, professional practice, ethics, global issues, engineering careers, and other relevant topics.

**CEEG 3NT. Civil and Environmental Engineering Non-traditional Study. .25-4 Credits.**

**Offered Fall, Spring, Summer; Lecture hours:Varies**

Non-traditional study in civil engineering. Prerequisite: permission of the instructor.

**CEEG 401. Structural Analysis. 1 Credit.**

**Offered Either Fall or Spring; Lecture hours:3,Other:2**

Analysis of structures including: review of essential mechanics; sketching deflection, moment, and force diagrams for indeterminate systems; influence lines; application of virtual force and displacement principles; and a comprehensive study of the direct stiffness method with a focus on matrix analysis. Prerequisites: CEEG 300 and ENGR 212 or permission of the instructor.

**CEEG 403. Wood Engineering Design Principles. 1 Credit.**

**Offered Either Fall or Spring; Lecture hours:3**

Wood properties as construction material; design of beams, columns, fasteners, and connections. Glued-laminated timber and many other uses for structures in accordance with the National Design Specifications. Form work for concrete structures, plywood and plywood diaphragms. Prerequisite: CEEG 300 or permission of the instructor.

**CEEG 405. Design of Steel Structures. 1 Credit.**

**Offered Either Fall or Spring; Lecture hours:3,Other:2**

Introduction to behavior and design of steel structures and elements, including tension members, compression members, beams, beam-columns and connections. Limit states design philosophy is emphasized through the use of AISC specifications. Design loads according to contemporary standards, and international building codes.

**CEEG 406. Design of Concrete Structures. 1 Credit.**

**Offered Either Fall or Spring; Lecture hours:3,Lab:2**

Introduction to behavior and design of concrete elements and structures: beams, columns, slabs, footings, bridges. Reinforced and prestressed concrete. Material properties and behavior, flexural and shear strength, serviceability and deflections. Use of relevant codes and specifications including ACI and AASHTO. Design loads according to contemporary standards and international building codes.

**CEEG 407. Prestressed Concrete. 1 Credit.**

**Offered Either Fall or Spring; Lecture hours:3,Other:2**

Analysis and design of prestressed concrete members and structures: flexural stresses, flexural strength, shear strength, loss of prestress, deflections. Prerequisites: CEEG 406 and permission of the instructor.

**CEEG 408. Finite Element Methods. 1 Credit.**

**Offered Either Fall or Spring; Lecture hours:3,Other:2**

Fundamental theory and applications for civil/mechanical engineering, and engineering mechanics stress analysis problems. One-, two-, three-dimensional and axisymmetric elements, and their formulations; stress recovery techniques; modeling considerations; convergence criteria and error estimates, includes use of commercial and developmental finite element analysis programs. Prereq: CEEG 401 or permission of instructor. Crosslisted as CEEG 608 and MECH 467 and MECH 667.

**CEEG 409. Earthquake Engineering. 1 Credit.**

**Offered Spring Semester Only; Lecture hours:3,Other:2**

Analysis and design of structures subjected to earthquakes. Single and multi degree-of-freedom systems, response spectra, seismology, soil dynamics. Seismic design methods in building codes. Isolation and energy dissipation systems. Laboratory to include experiments with shake table. Prerequisite: CEEG 300 or permission of the instructor.

**CEEG 419. Advanced Topics in Structural Engineering. 1 Credit.**

**Offered Either Fall or Spring; Lecture hours:4**

Topics will vary. Prerequisite: permission of the instructor.

**CEEG 421. Hydrology. 1 Credit.**

**Offered Either Fall or Spring; Lecture hours:3,Other:2**

The interrelation of meteorological conditions, precipitation, surface runoff, and groundwater storage. Prerequisites: CEEG 320 and permission of the instructor.

**CEEG 422. River Mechanics. 1 Credit.**

**Offered Spring Semester Only; Lecture hours:3,Other:2**

Mechanics of free-surface flows in rivers; introduction to sediment transport mechanisms; application to river engineering design (bridge crossings, culverts, flood control, river stabilization). Prerequisites: ENGR 222 and permission of the instructor.

**CEEG 425. Groundwater. 1 Credit.**

**Offered Occasionally; Lecture hours:3,Other:2**

The study of the occurrence of groundwater, the laws and equations governing storage and movement of groundwater, and the interaction between surface and ground waters. Prerequisite: permission of the instructor.

**CEEG 429. Advanced Topics in Water Resources Engineering. 1 Credit.****Offered Either Fall or Spring; Lecture hours:3,Other:2**

Topics will vary. Prerequisite: permission of the instructor.

**CEEG 430. Introduction to Roadside Safety. 1 Credit.****Offered Fall Semester Only; Lecture hours:4**

Fundamentals of roadside safety design and analysis: topics include traffic barrier warranting and selection, crash data analysis, hardware performance evaluation, and benefit/cost analysis. Prerequisite: CEEG 330 or permission of the instructor.

**CEEG 431. Introduction to Urban and Regional Planning. 1 Credit.****Offered Either Fall or Spring; Lecture hours:4**

Problems of urban and regional planning and the treatment of various factors of a comprehensive plan. Emphasis on the sustainability and the interrelationships between engineering, sociology, geography, and economics. Prerequisite: permission of the instructor.

**CEEG 432. Sustainable Transportation Planning. 1 Credit.****Offered Either Fall or Spring; Lecture hours:3,Other:2**

Application of multimodal design principles, urban and regional planning approaches, and innovative transportation technologies associated with smart cities. Planning and design of transportation systems in order to enhance mobility while simultaneously reducing impacts on the environment, society, and the economy. Prerequisite: CEEG 330 or permission of the instructor.

**CEEG 435. Fundamentals of Transportation Safety Data Analysis. 1 Credit.****Offered Alternating Fall Semester; Lecture hours:4**

Application of statistical techniques to analyze transportation safety data and predict crash events/characteristics; topics include crash data availability, data manipulation techniques, statistical model selection/implementation, use of safety performance functions, and advanced network screening methods.

**CEEG 436. Advanced Traffic Engineering. 1 Credit.****Offered Either Fall or Spring; Lecture hours:3,Other:2**

Introduction to traffic engineering elements, including traffic flow theory, queue theory, geometric design and signal design. Students will learn to use traffic design and simulation software. Prerequisite: CEEG 330 or permission of the instructor.

**CEEG 439. Advanced Topics in Transportation. .5-1 Credits.****Offered Either Fall or Spring; Lecture hours:4**

Topics will vary. Prerequisite: permission of the instructor.

**CEEG 440. Unit Operations and Processes in Environmental Engineering. 1 Credit.****Offered Spring Semester Only; Lecture hours:3,Other:2**

Fundamentals of unit operations and processes used to remove pollutants from water, air, and soil such as coagulation, sedimentation, filtration, disinfection, adsorption, membrane separation, and biological transformations. Laboratory experiments reinforce theory and inform system design and evaluation. Prerequisites: CEEG 340 and open to Environmental Engineering majors. All others may waitlist. Crosslisted as CEEG 640.

**CEEG 441. Environmental Engineering Biotechnology. 1 Credit.****Offered Fall Semester Only; Lecture hours:3,Other:2**

Theory and design of biological waste treatment systems for industrial, municipal and hazardous pollutants and natural biotransformation of pollutants in the environment. Laboratory experience on startup, operation, and analysis of systems that biodegrade pollutants and produce useful forms of energy. Prerequisite: CEEG 340 or instructor permission. Crosslisted as CEEG 641.

**CEEG 442. Sustainability Principles for Engineers. 1 Credit.****Offered Spring Semester Only; Lecture hours:4**

An introduction to concepts for the application of sustainable engineering principles. Topics include life-cycle assessment, biogeochemical cycles, climate change, fossil fuels and renewable energy, embedded water, global and cultural context, market externalities, sustainability metrics, and carbon footprint. Prerequisite: CEEG 340 or third- or fourth-year engineers with permission of the instructor. Crosslisted as CEEG 642.

**CEEG 443. Sustainable Design. 1 Credit.****Offered Spring Semester Only; Lecture hours:3,Lab:2**

Students will learn principles of quantitative sustainable design for environmental systems, such as bio-based chemical production. They will apply technoeconomic analysis (TEA) and environmental life cycle assessment (LCA) to engineering design under uncertainty. Reading, discussion, and computational tools are central to the course. Crosslisted as CEEG 643.

**CEEG 444. Hazardous Waste Management. 1 Credit.****Offered Spring Semester Only; Lecture hours:3,Other:2**

Identification of common hazardous chemicals and related industrial activities, determination of risk-based clean up levels for hazardous waste sites, toxicology, pump-and-treat ground water remediation, in situ bioremediation, legal and liability issues, and remedial action. Prerequisites: CEEG 340 and open to Environmental Engineering majors. All others may waitlist. Crosslisted as CEEG 644.

**CEEG 445. Environmental Engineering Chemistry. 1 Credit.****Offered Either Fall or Spring; Lecture hours:3,Other:2**

Principles of aquatic chemistry and applications with emphasis on acid-base reactions, metal speciation and solubility, and oxidation-reduction reactions in water. Prerequisite: CEEG 340 or permission of the instructor.

**CEEG 447. Sustainable Cities. 1 Credit.**

**Offered Fall Semester Only; Lecture hours:3,Other:2**

This team taught course introduces students to the core concepts of sustainability and how they have been applied to promote sustainability in London, the UK, and Europe. This course is part of Bucknell in London core course. Prerequisite: permission of the instructor. Crosslisted as ENST 347.

**CEEG 448. Air Quality / Hazardous Waste Management. 1 Credit.**

**Offered Either Fall or Spring; Lecture hours:3,Other:2**

Air quality topics: regulations, airborne pollutants and sources, treatment technology design, and air quality/climate change relationship. Hazardous waste topics: identification of hazardous chemicals and sources, risk-based clean-up of contaminated sites, toxicology, pump-and-treat remediation, in situ bioremediation, legal and liability issues, and remedial action. Prerequisite: CEEG 340 or instructor permission. Crosslisted as CEEG 648.

**CEEG 449. Advanced Topics in Environmental Engineering. 1 Credit.**

**Offered Fall Semester Only; Lecture hours:4**

Advanced topics course for Civil and Environmental Engineering. Prerequisite: permission of the instructor.

**CEEG 450. Geotechnical Engineering II. 1 Credit.**

**Offered Fall Semester Only; Lecture hours:3,Lab:2**

Application of the theories and principles of soil mechanics to foundation design. Subsurface investigations; methods of analysis, design, and construction of foundations; bearing capacity and settlement of shallow and deep foundations; excavation and bracing; earth structures. Prerequisite: CEEG 350 or permission of the instructor.

**CEEG 451. Environmental Geotechnology. 1 Credit.**

**Offered Spring Semester Only; Lecture hours:3,Other:2**

Interaction between hazardous and toxic wastes and geotechnical properties of soils. Remediation of the subsurface environment. Prerequisite: CEEG 350 or permission of the instructor.

**CEEG 452. Ground Improvement Engineering. 1 Credit.**

**Offered Spring Semester Only; Lecture hours:3,Other:2**

Application of soil mechanics principles to improving the engineering characteristics of soils. Includes mechanisms of soil stabilization, grouting, deep dynamic compaction, reinforced earth, sand drains, and preconsolidation. Prerequisites: CEEG 350 and permission of the instructor.

**CEEG 453. Advanced Soil Mechanics. 1 Credit.**

**Offered Occasionally; Lecture hours:3,Other:3**

Advanced study of the theories of strength, hydraulic conductivity and compressibility. Critical review of soil origin and composition effects upon the physical and engineering properties of soils. Introduction to soil dynamics. Planning, execution, and interpretation of soil testing programs. Prerequisites: CEEG 350 and permission of the instructor.

**CEEG 454. Unsaturated Soil Mechanics. 1 Credit.**

**Offered Spring Semester Only; Lecture hours:3,Other:2**

Extension of the theories and principles of soil mechanics for soils in a partially saturated state. Emphasis is on the hydraulic and stress-deformation properties of soil and their history. Knowledge from this course can be applied across civil engineering disciplines. Prerequisite: CEEG 350, CENG 350 or permission of instructor. Crosslisted as CEEG 654.

**CEEG 459. Advanced Topics in Geotechnical Engineering. 1 Credit.**

**Offered Either Fall or Spring; Lecture hours:4**

Topics will vary. Prerequisite: permission of the instructor.

**CEEG 472. Construction Engineering. 1 Credit.**

**Offered Spring Semester Only; Lecture hours:3,Lab:2**

Building methods and design of temporary structures such as formwork, sheet piles, soldier piles, scaffolding, etc. Calculation and optimization of earth moving operations, heavy civil construction management methods, and equipment selection. Crosslisted as CEEG 672.

**CEEG 475. Forensic Engineering. 1 Credit.**

**Offered Either Fall or Spring; Lecture hours:4**

Introduction to identification, evaluation and analysis of a wide variety of engineering failures; failure investigation and the legal process; serviceability failure, material or system failure, design errors; expert witness testimony. Prerequisite: senior status.

**CEEG 479. Advanced Topics in Construction Engineering and Management. 1 Credit.**

**Offered Either Fall or Spring; Lecture hours:3,Other:2**

Topics will vary. Prerequisite: permission of the instructor.

**CEEG 480. Special Topics in Civil Engineering. .25-1 Credits.**

**Offered Either Fall or Spring; Lecture hours:Varies; Repeatable**

Individual projects in laboratory work, design, or library studies, depending upon the nature of the problem selected. Prerequisite: permission of the instructor.

**CEEG 481. Undergraduate Research. .5-1 Credits.**

**Offered Either Fall or Spring; Lecture hours:Varies,Other:Varies; Repeatable**

Original investigations in structural engineering, transportation engineering, environmental engineering, geotechnical engineering, or water resource engineering.

**CEEG 490. Engineering Planning and Project Management. 1 Credit.****Offered Fall Semester Only; Lecture hours:3,Lab:2**

Exploration and application of the civil engineering planning process including feasibility study, decision making, engineering economic analysis, and project management skills. Prerequisites: open to senior civil or environmental engineering majors. All others by permission of the instructor.

**CEEG 491. Civil Engineering Design. 1 Credit.****Offered Spring Semester Only; Lecture hours:2,Other:10**

A comprehensive design of a civil engineering project that integrates at least two subdisciplines of civil engineering. Projects are designed by teams of two to four students and must involve analysis and synthesis to produce design solutions that achieve the desired "client" needs within specified constraints. A weekly seminar series by practicing engineers and others focuses on ethics, professionalism, global issues, and engineering careers. Prerequisite: CEEG 490.

**CEEG 492. Civil Engineering Planning and Design I. 1 Credit.****Offered Fall Semester Only; Lecture hours:1,Lab:2**

Planning process including feasibility study. Professional practice issues. Initial design of a civil engineering project that integrates at least two subdisciplines of civil engineering. Projects are designed by teams and must involve analysis and synthesis to produce design solutions that achieve the desired "client" needs within specified constraints.

**CEEG 493. Civil Engineering Design II. .5 Credits.****Offered Spring Semester Only; Lecture hours:Varies,Other:1.5**

Final, comprehensive design of a civil engineering project that integrates at least two subdisciplines of civil engineering. Projects are designed by teams of two to four students and must involve analysis and synthesis to produce design solutions that achieve the desired "client" needs within specified constraints. Prerequisite: CEEG 492.

**CEEG 495. Advanced Topics in Engineering Mathematics. 1 Credit.****Offered Fall Semester Only; Lecture hours:4**

Linear algebra and analytical/computational techniques for solving ordinary and partial differential equations relevant to engineering applications. Prerequisite: permission of the instructor. Crosslisted as CHEG 495 and ECEG 495 and MECH 495 and ENGR 695.

**CEEG 4NT. Civil and Environmental Engineering Non-traditional Study. .25-4 Credits.****Offered Fall, Spring, Summer; Lecture hours:Varies; Repeatable**

Non-traditional study in civil and environmental engineering. Prerequisite: permission of the instructor.