

# Environmental Engineering (EVEG)

## 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.

## 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	ENGR 101	.5
MATH 201	1	MATH 202	1
PHYS 211	1	ENGR 229	1
Elective: Recommended - English course or foundation seminar that fulfills the W1 Writing Program requirement	1	GEOL 250	1
		Sustainability Perspectives 1	1
	<b>4</b>		<b>4.5</b>

### Sophomore

First Semester	Credits	Second Semester	Credits
CENG 240	1	BIOL 208	1
CHEM 201	1	CENG 242	1
ECON 103	1	ENGR 200	1
MATH 211	1	ENGR 222	1
MATH 226	.5	MATH 222	.5
	<b>4.5</b>		<b>4.5</b>

### Junior

First Semester	Credits	Second Semester	Credits
CENG 320	1	ENGR 212	.5
CENG 350	1	CENG 440	1
CENG 445	1	Technical elective	1
Unrestricted elective	1	Unrestricted elective	1

	Sustainability Perspectives 2	1
	<b>4</b>	<b>4.5</b>
<b>Senior</b>		
<b>First Semester</b>	<b>Credits</b>	<b>Second Semester</b>
CENG 490	1	CENG 491
CENG 441	1	CENG 444
Technical elective	1	CENG 443
Sustainability Perspectives 3	1	Unrestricted elective
	<b>4</b>	<b>4</b>

Total Credits: 34

- Sustainability perspectives: four required (One course from each group on approved list, plus ECON 103 (<http://coursecatalog.bucknell.edu/archive/2014-2015/search/?P=ECON%20103>) Economic Principles and Problems ).
- Three unrestricted electives. These can be used to pursue additional interests or further develop expertise in a specific area.
- Two technical electives, selected from a pre-approved 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.
- Each student must fulfill the University writing requirement by completing one W1 course in the first year, followed by at least two W2 courses in subsequent years.
- Fulfillment of the MATH requirement may 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 and Environmental Engineering.

## Faculty

**Professors:** Richard Crago, Thomas D. DiStefano, Jeffrey C. Evans, Matthew J. Higgins

**Associate Professor:** Michael A. Malusis

**Assistant Professors:** Kevin Gilmore, Jessica Newlin, Deborah L. Sills

## Courses

### **CENG 240. Environmental Engineering. 1 Credit.**

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

An introduction to the fundamentals of environmental engineering and science such as chemistry, microbiology, mass balance, and reactor theory. Application of fundamental concepts to environmental engineering includes water quality, water and wastewater treatment, solid and hazardous waste, air pollution, greenhouse gases and climate change. The course includes hands-on laboratory component with a focus on experiential learning. Prerequisite: ENGR 222 or permission of the instructor.

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

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

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: CENG 240 or third- or fourth-year engineers with permission of the instructor.

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

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

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 and global context of structural design. Case studies used throughout the course. Prerequisites: ENGR 230 and ENGR 242 or permission of the instructor.

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

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

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.

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

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

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

**CENG 350. Geotechnical Engineering I. 1 Credit.****Offered Fall Semester Only; Lecture hours:3,Other: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 230 or permission of the instructor.

**CENG 3NT. Civil Engineering Non-traditional Study. 1 Credit.****Offered Fall, Spring, Summer; Lecture hours:Varies**

Nontraditional study in civil engineering. Prerequisite: permission of the instructor.

**CENG 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: CENG 300 and ENGR 212 or permission of the instructor.

**CENG 403. Wood Engineering Design Principles. 1 Credit.****Offered Either Fall or Spring; Lecture hours:3,Other:2**

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: CENG 300 or permission of the instructor.

**CENG 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. Prerequisite: CENG 300 or permission of the instructor.

**CENG 406. Design of Concrete Structures. 1 Credit.****Offered Either Fall or Spring; Lecture hours:3,Other: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 ASSHTO. Design loads according to contemporary standards and international building codes. Prerequisite: CENG 300 or permission of the instructor.

**CENG 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: CENG 406 and permission of the instructor.

**CENG 408. Finite Element Methods. 1 Credit.****Offered Either Fall or Spring; Lecture hours:3,Other:2**

Fundamental theory and applications for civil engineering, mechanical engineering, and engineering mechanics stress analysis problems. One-, two-, and three-dimensional elements, 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. Prerequisite: CENG 401 or permission of the instructor. Crosslisted as MECH 467.

**CENG 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: CENG 300 or permission of the instructor.

**CENG 419. Advanced Topics in Structural Engineering. 1 Credit.****Offered Either Fall or Spring; Lecture hours:4**

Topics will vary. Prerequisite: permission of the instructor.

**CENG 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: CENG 320 and permission of the instructor.

**CENG 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.

**CENG 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.

**CENG 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.

**CENG 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. Prerequisites: CENG 330 or permission of the instructor.

**CENG 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.

**CENG 432. Sustainable Transportation Planning. 1 Credit.**

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

This course will explore the balance of enhancing mobility while simultaneously reducing impacts on the environment, society, and the economy. Prerequisite: CENG 330 or permission of the instructor.

**CENG 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: CENG 330 or permission of the instructor.

**CENG 440. Physical and Chemical Treatment Processes. 1 Credit.**

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

Fundamental principles of physical and chemical treatment processes used to remove pollutants from water, air, and soil such as ion-exchange, coagulation, sedimentation, filtration, air stripping, disinfection, adsorption, and membrane processes. Laboratory experiments are used to reinforce theory and to develop design criteria for full-scale treatment processes. Prerequisite: CENG 240 or permission of the instructor.

**CENG 441. Environmental Engineering Biotechnology. 1 Credit.**

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

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: CENG 240 or permission of the instructor.

**CENG 443. Systems and Life Cycle Assessment. 1 Credit.**

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

Systems topics include definitions, causal loops, systems dynamics, emergence, self-organization, and complexity. Life cycle assessment (LCA) includes standardized methodologies, LCA projects, and sensitivity analyses. Reading, discussion, and computational tools are central to the course. Prerequisite: CENG 242 or permission of the instructor.

**CENG 444. Hazardous Waste Management. 1 Credit.**

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

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. Prerequisite: CENG 240 or permission of the instructor.

**CENG 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: permission of the instructor.

**CENG 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.

**CENG 448. Air Quality and Hazardous Waste. 1 Credit.**

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

Air quality topics include regulations, airborne pollutants and sources, design of treatment technologies, and relationship of air quality to climate change. Hazardous waste topics include identification of hazardous chemicals and their sources, risk-based clean-up of contaminated sites, toxicology, pump-and-treat remediation, in situ bioremediation, legal and liability issues, and remedial action. Prerequisite: CENG 240 or permission of the instructor.

**CENG 449. Advanced Topics in Environmental Engineering. 1 Credit.****Offered Fall Semester Only; Lecture hours:4; Repeatable**

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

**CENG 450. Geotechnical Engineering II. 1 Credit.****Offered Fall Semester Only; Lecture hours:3,Other: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: CENG 350 or permission of the instructor.

**CENG 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: permission of the instructor.

**CENG 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: CENG 350 and permission of the instructor.

**CENG 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: CENG 350 and permission of the instructor.

**CENG 459. Advanced Topics in Geotechnical Engineering. 1 Credit.****Offered Either Fall or Spring; Lecture hours:4**

Topics will vary. Prerequisite: permission of the instructor.

**CENG 472. Construction Engineering. 1 Credit.****Offered Fall Semester Only; Lecture hours:3,Other:2**

Project documents, processes, and organizational structures. Construction estimating, equipment, labor, and procurement. Building methods and materials. Prerequisite: junior status or permission of the instructor.

**CENG 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.

**CENG 479. Advanced Topics in Construction Engineering and Management. 1 Credit.****Offered Either Fall or Spring; Lecture hours:3,Other:2; Repeatable**

Topics will vary. Prerequisite: permission of the instructor.

**CENG 480. Special Topics in Civil Engineering. .5-1 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.

**CENG 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.

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

Planning process including feasibility study, decision making, optimization concepts, engineering economy, and project scheduling, control and management. Prerequisite: senior status.

**CENG 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: CENG 490.

**CENG 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, ELEC 495, MECH 495.

**CENG 4NT. Civil Engineering Non-traditional Study. .5-4 Credits.**

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

Nontraditional study in civil engineering. Prerequisite: permission of the instructor.