

ENVIRONMENTAL ENGINEERING

Faculty

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Vision

Bucknell University's civil and environmental engineering programs prepare the next generation of leaders in the stewardship of our natural and built environment for the benefit of the planet, communities and people.

Mission

Bucknell University's civil and environmental engineering programs provide an excellent undergraduate education in a four-year curriculum. We deliver a student-centered educational experience with outstanding teaching, small class sizes, hands-on and experiential learning, and close classroom and research interaction with approachable faculty and staff. Our priorities include:

- creating an **inclusive and supportive community** in which all voices are valued and respected, diverse perspectives are embraced, and students, staff and faculty of all backgrounds and identities can thrive;
- providing the **breadth and depth of technical training** necessary for students to excel in professional positions and graduate programs;
- developing strong **critical thinking and communication skills**;
- instilling a mindset of **sustainability, equity, justice and ethical responsibility** to improve the lives of all people;
- integrating **perspectives from the arts, humanities, social sciences, management and engineering**, which are all uniquely provided at Bucknell, to address global and societal challenges; and
- inspiring **intellectual curiosity and the confidence to learn independently**.

Program Educational Objectives (PEOs)

The environmental engineering program seeks to prepare students to be successful professionals who excel in:

1. critical thinking, problem-solving, and communication skills
2. ability to work collaboratively and inclusively on diverse teams and within communities
3. practicality, creativity and adaptability to new situations
4. integration of equity, ethics, sustainability and the needs of underrepresented populations
5. professional development and intellectual growth

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>).

Bachelor of Science in Environmental Engineering

The Bachelor of Science in Environmental Engineering requirements are:

First Year

First Semester	Credits	Second Semester	Credits
ENGR 099		0 CEEG 242	1
ENGR 100		1 ENGR 101	.5
MATH 201		1 ENGR 229	1
PHYS 211		1 GEOL 250	1
Foundation Seminar (W1)		1 MATH 202	1
		4	4.5

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
Elective		1 Elective	1
		4.5	4.5

Junior

First Semester	Credits	Second Semester	Credits
CEEG 290		.5 Four Electives	4
CEEG 320		1 CEEG 390	0
CEEG 350		1	
CEEG 445		1	
ENGR 212		.5	
		4	4

Senior

First Semester	Credits	Second Semester	Credits
CEEG 441		1 CEEG 443	1
CEEG 492		1 CEEG 444	1
Two Electives		2 CEEG 493	.5
		Two Electives	2
		4	4.5

Total Credits: 34

The elective courses shown above are distributed as follows:

- A student must choose electives that meet engineering college requirements for general education and global perspectives (<https://coursecatalog.bucknell.edu/collegeofengineeringcurricula/curriculaoverview/>).
- Six unrestricted electives. These can be used to pursue additional interests or further develop expertise in a specific area.
- Three courses in each student's program must fulfill the University writing requirement that includes a W1 course taken in the first semester, foundation seminar (FOUN or RESC), and two subsequent W2 courses.

Bachelor of Arts/Management for Engineers - Bachelor of Science in Environmental Engineering

The Bachelor of Arts/Management for Engineers - Bachelor of Science in Environmental Engineering requirements are:

First Year

First Semester	Credits	Second Semester	Credits
ENGR 099		0 CEEG 242	1
ENGR 100		1 ENGR 101	.5
MATH 201		1 ENGR 229	1
PHYS 211		1 GEOL 250	1
Foundation Seminar (W1)		1 MATH 202	1
	4		4.5

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
Elective		1 Elective	1
	4.5		4.5

Junior

First Semester	Credits	Second Semester	Credits
CEEG 290		.5 CEEG 390	0
CEEG 320 or 350		1 Four Electives	4
CEEG 445		1	
ENGR 212		.5	
Elective		1	
	4		4

Senior

First Semester	Credits	Second Semester	Credits
CEEG 320 or 350		1 CEEG 443	1
CEEG 441		1 CEEG 444	1
Two Electives		2 Two Electives	2
	4		4

Five Year

First Semester	Credits	Second Semester	Credits
CEEG 492		1 CEEG 493	.5
Three Electives		3 Four Electives	4
	4		4.5

Total Credits: 42

The elective courses shown above include:

- Courses used to fulfill the General Education (<https://coursecatalog.bucknell.edu/collegeofengineeringcurricula/curriculaoverview/>) requirements for engineering students should also fulfill the College of Arts & Sciences Core Curriculum (CASCC) (<https://coursecatalog.bucknell.edu/collegeofartsandsciencescurricula/curriculaoverview/collegecorecurriculum/>) requirements for those in the 5-year Engineering & Liberal Arts dual degree program or the Freeman College of Management General Education Curriculum (<https://coursecatalog.bucknell.edu/collegeofmanagementcurricula/curriculaoverview/gened/>) requirements for those in the 5-year Engineering & Management dual degree program.
- Three courses in each student's program must fulfill the University writing requirement that includes a W1 course taken in the first semester, foundation seminar (FOUN or RESC), and two subsequent W2 courses.
- Eight courses selected to satisfy the major requirements for the Bachelor of Arts/Management for Engineers major.

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 and Environmental 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 and environmental 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.

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 and Environmental 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 and environmental engineering majors. Presentations by practicing engineers and others covering multiple sub-disciplines of civil and environmental 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 and environmental 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 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 Occasionally; Lecture hours:3,Other:2**

Fundamental theory and applications for civil and mechanical engineering. Multidimensional 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. Prerequisites: CEEG 300 or permission of the instructor. Crosslisted as CEEG 608 and MECH 467 and MECH 667.

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. Crosslisted as CEEG 630.

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 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 443. Sustainable Design. 1 Credit.**Offered Spring Semester Only; Lecture hours:3,Other: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 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 Either Fall or Spring; 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. Prerequisite: ENGR 229. Crosslisted as CEEG 672.

CEEG 474. Safety and Risk Management. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3,Lab:2**

Specific topics for this course will include: causes and prevention of Architecture-Engineering-Construction (AEC) Industry Incidents, OSHA regulations and requirements, design of accident prevention programs and the identification-analysis-response and management of AEC industry related risks. Prerequisite: CEEG 290. Crosslisted as CEEG 674.

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 and Environmental 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 492. Civil and Environmental 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 project that integrates at least two subdisciplines of civil and environmental 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 and Environmental Engineering Design II. .5 Credits.**Offered Spring Semester Only; Lecture hours:Varies,Other:2.5**

Final, comprehensive design of a project that integrates at least two subdisciplines of civil and environmental 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. 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.