Department of Civil and Environmental Engineering

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Location: Porter Hall 119-D
www.cmu.edu/cee (http://www.cmu.edu/cee/)

The role of civil and environmental engineers, in the broadest sense, is to apply science and technology to develop sustainable solutions to meet society's needs. Civil engineers plan, design, construct, operate, and maintain infrastructure used daily by the public and industry, such as buildings, transportation networks, water systems, and energy distribution systems. Civil and environmental engineers are at the forefront of technological developments to address the biggest societal challenges. They work to protect public health and the environment. Today's civil and environmental engineers are also called upon by government and industry to provide leadership on complex technical and societal issues such as demands for infrastructure improvement, remediation of former industrial sites for reuse, renewable energy, climate change adaptation, provision of safe drinking water, smart transportation systems, and sustainable development.

The department offers undergraduate degree programs leading to a B.S. in Civil Engineering or a B.S. in Environmental Engineering. The B.S. in Civil Engineering provides a broad exposure to the field and its sub-disciplines, including environmental engineering. The B.S. in Environmental Engineering offers the opportunity to focus primarily on environmental sciences and engineering. The two programs share a number of common courses.

The Civil Engineering and Environmental Engineering curricula emphasize fundamental understanding of the behavior of constructed facilities and the natural environment and the design of infrastructure through the application of the physical sciences, chemistry, biology, mathematics, and computing. In addition to providing a solid technical foundation, the programs emphasize the development of professional skills. We incorporate design and team experiences throughout the curriculum, and provide hands-on experience in laboratory and project courses. Students also have multiple opportunities to practice and improve their communication skills through reports, presentations, and team activities.

The curricula allow many opportunities for students to pursue areas of personal interest. Students may pursue a minor in one of the designated minor programs offered in the College of Engineering or elsewhere in the university or an additional major. Students may also choose to concentrate in a specialty area in civil or environmental engineering. Students are encouraged to participate in research with department faculty members, explore their chosen field through internships, and take advantage of opportunities to study abroad and be exposed to other cultures. Faculty mentors and the Director of Undergraduate Programs are available to discuss students' educational goals and help define a path to reach them.

The Department of Civil and Environmental Engineering offers a wide spectrum of opportunities for entry into the engineering profession, for graduate education in engineering, or entry into various other graduate and professional fields, including business, law, and medicine. Our curricula emphasize the development of scientific inquiry in the context of applications in civil and environmental engineering. For B.S. graduates who wish to enter the engineering profession directly in such specialties as structural engineering, construction engineering, computer-aided engineering, or environmental engineering, this approach to teaching allows application of the most advanced technological developments. Those who wish to pursue graduate study are prepared to engage in research on the highest level, either in traditional specialties or in emerging fields such as smart infrastructure, climate change adaptation, and micromechanics.

Program Educational Objectives

The Program Educational Objectives are broad statements that describe what graduates are expected to attain within a few years of graduation. The objectives of the Bachelor of Science in Civil Engineering program are to develop graduates who embody the following definitions:

- Graduates distinguish themselves within their organizations as individuals able to provide sustainable solutions to a wide range of conventional, cutting-edge, and emerging professional challenges related to one or more of the areas of the built, natural, and information environments.
- Graduates are innovative, proactive, and adaptive professionals, highly engaged in their professional communities; graduates are prepared to take on leadership positions within their organizations and communities.
- Graduates are able to contribute and collaborate on developing sustainable solutions to local and global problems; graduates are able to cross geographic, cultural, and traditional discipline boundaries in developing solutions; graduates are able to develop just and equitable solutions.

The Bachelor of Science in Civil Engineering program is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org.

By the end of the B.S. program, students should have achieved the following student outcomes:

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 curriculum has been designed, and is periodically evaluated and refined, to provide students instruction and experiences that lead to the development of these abilities and skills.

The Bachelor of Science in Environmental Engineering will complete its first cycle of graduating students in May 2024 and will be formally evaluated by ABET later that year. The program was designed in accordance with ABET general and program criteria. Accreditation would be applicable retroactively to the May 2024 graduates.

Curriculum: B.S. Civil Engineering

Minimum units required for B.S. in Civil Engineering 384

Students entering the College of Engineering declare a major near the end of the first year. First-year students take two introductory engineering courses as well as some restricted technical electives within the common foundation specified for first-year engineering students. By the end of the sophomore year, a Civil Engineering major is expected to have completed the Restricted Technical Electives in the following list and 12-100 Exploring CEE: Infrastructure and Environment in a Changing World.

Restricted Technical Electives		Units
09-101	Introduction to Experimental Chemistry	3
09-105	Introduction to Modern Chemistry I	10
or 09-111	Nanolegos: Chemical Building Blocks	
15-110	Principles of Computing	10
21-120	Differential and Integral Calculus	10
21-122	Integration and Approximation	10
21-259	Calculus in Three Dimensions	9
or 21-254	Linear Algebra and Vector Calculus for Engineers	
21-260	Differential Equations	9
33-141	Physics I for Engineering Students	12
33-142	Physics II for Engineering and Physics Students	12

Notes on Math Requirements

1. All mathematics (21-xxx) courses required for the engineering degree taken at Carnegie Mellon must have a minimum grade of C in order to be counted toward the graduation requirement for the BS engineering degree.
2. A minimum grade of C must be achieved in any required mathematics (21-xxx) course that is a pre-requisite for the next higher level required mathematics (21-xxx) course.

Sample Curriculum

This section shows the recommended four-year program of study for the BS in Civil Engineering following a typical path. The curriculum for transfer students, students with advanced placement credit, and students planning to study abroad will not follow the same path. Students need to consult the department for appropriate advising and formulation of a plan to complete the degree within eight semesters.

First Year

Fall		Units
12-100	Exploring CEE: Infrastructure and Environment in a Changing World	12
21-120	Differential and Integral Calculus	10
33-141	Physics I for Engineering Students	12
99-10x	Computing @ Carnegie Mellon	3
xx-xxx	General Education Course	9
		46

Spring		Units
xx-xxx	Introduction to Engineering (other than CEE)	12
21-122	Integration and Approximation	10
33-142	Physics II for Engineering and Physics Students	12
09-101	Introduction to Experimental Chemistry	3
xx-xxx	General Education Course	9
		46

Sophomore Year

Fall		Units
12-200	CEE Challenges: Design in a Changing World	9
12-212	Statics	9
12-233	CEE Infrastructure Systems in Action	2
21-259	Calculus in Three Dimensions	9
or 21-254	Linear Algebra and Vector Calculus for Engineers	
15-110	Principles of Computing	10
xx-xxx	General Education Course	9
39-210	Experiential Learning I	0
		48

Spring		Units
12-231	Solid Mechanics	9
12-234	Sensing and Data Acquisition for Engineering Systems	4
12-271	Computation and Data Science for Civil & Environmental Engineering	9
21-260	Differential Equations	9
36-220	Engineering Statistics and Quality Control	9
xx-xxx	General Education Course	9
39-220	Experiential Learning II	0
		49

Junior Year

Fall		Units
12-301	CEE Projects: Integrating the Built, Natural and Information Environments	9
12-335	Soil Mechanics	9
12-355	Fluid Mechanics	9
12-356	Fluid Mechanics Lab	2
09-111	Nanolegos: Chemical Building Blocks	9
or 09-105	Introduction to Modern Chemistry I	
xx-xxx	Elective 1	9
39-310	Experiential Learning III	0
		47

Spring		Units
12-351	Environmental Engineering	9
27-357	Introduction to Materials Selection	6
12-371	Advanced Computing and Problem Solving in Civil and Environmental Engineering	9
12-333	Experimental & Sensing Systems Design and Computation for Infrastructure Systems	4
xx-xxx	Elective 2	9
xx-xxx	General Education Course	9
		46

Senior Year

Fall		Units
12-401	CEE Design: Imagine, Build, Test	12
12-411	Project Management for Engineering and Construction	9
xx-xxx	Elective 3	9
xx-xxx	Elective 4	9
xx-xxx	General Education Course	9
		48

Spring		Units
xx-xxx	General Education Course	9
xx-xxx	General Education Course	9
xx-xxx	Elective 5	9
xx-xxx	Elective 6	9
xx-xxx	Elective 7	9
xx-xxx	Elective 8	9
		54

Notes on Electives

1. One elective must be in the basic sciences, from the following list:

03-121	Modern Biology	9
12-201	Geology	9
12-353	Environmental Biology and Ecology	9

   Substitutions may be made only with the approval of the Department Head.

2. One elective course is restricted to a 600-level or 700-level Civil Engineering course of at least 9 units, except 12-648 and 12-690. The combination of 12-644 and 12-645 may also be used, but no other combination is allowed.
3. **Students are encouraged to take multiple 12-6xx and 12-7xx courses to provide them with specific civil engineering domain depth in their field(s) of interest.**

Curriculum: B.S. Environmental Engineering

Minimum units required for B.S. in Environmental Engineering 384

Students entering the College of Engineering declare a major near the end of the first year. First-year students take two introductory engineering courses as well as some restricted technical electives within the common foundation specified for first-year engineering students. By the end of the sophomore year, an Environmental Engineering major is expected to have completed the Restricted Technical Electives in the following list and 12-100 Exploring CEE: Infrastructure and Environment in a Changing World.

09-105 or 09-111	Introduction to Modern Chemistry I Nanolegos: Chemical Building Blocks	10
15-110	Principles of Computing	10
21-120	Differential and Integral Calculus	10
21-122	Integration and Approximation	10
21-254	Linear Algebra and Vector Calculus for Engineers	11
21-260	Differential Equations	9
33-141	Physics I for Engineering Students	12
33-142	Physics II for Engineering and Physics Students	12

Notes on Math Requirements

1. All mathematics (21-xxx) courses required for the engineering degree taken at Carnegie Mellon must have a minimum grade of C in order to be counted toward the graduation requirement for the BS engineering degree.
2. A minimum grade of C must be achieved in any required mathematics (21-xxx) course that is a pre-requisite for the next higher level required mathematics (21-xxx) course.

SAMPLE CURRICULUM

This section shows the recommended four-year program of study for the BS in Environmental Engineering following a typical path. The curriculum for transfer students, students with advanced placement credit, and students planning to study abroad will not follow the same path. Students need to consult the department for appropriate advising and formulation of a plan to complete the degree within eight semesters.

First Year

Fall		Units
12-100	Exploring CEE: Infrastructure and Environment in a Changing World	12
21-120	Differential and Integral Calculus	10
33-141	Physics I for Engineering Students	12
99-10x	Computing @ Carnegie Mellon	3
xx-xxx	General Education Course	9
		46

Spring		Units
xx-xxx	Introduction to Engineering (other than CEE)	12
21-122	Integration and Approximation	10
33-142	Physics II for Engineering and Physics Students	12
09-105 or 09-111	Introduction to Modern Chemistry I Nanolegos: Chemical Building Blocks	10
09-101	Introduction to Experimental Chemistry	3
		47

Sophomore Year

Fall		Units
12-200	CEE Challenges: Design in a Changing World	9
12-221	Environmental Chemistry and Thermodynamics	9
12-222	Environmental Chemistry Laboratory	3
15-110	Principles of Computing	10
21-254	Linear Algebra and Vector Calculus for Engineers	11
39-210	Experiential Learning I	0
xx-xxx	General Education Course	9
		51

Spring		Units
12-271	Computation and Data Science for Civil & Environmental Engineering	9
12-351	Environmental Engineering	9
12-352	Environmental Engineering Lab	3
21-260	Differential Equations	9
39-220	Experiential Learning II	0
xx-xxx	General Education Course	9
xx-xxx	Elective 1	9
		48

Junior Year

Fall		Units
12-301	CEE Projects: Integrating the Built, Natural and Information Environments	9
12-355	Fluid Mechanics	9
12-356	Fluid Mechanics Lab Starting in Fall 2022, 12-356 will be 2 units	2
03-121	Modern Biology	9
36-220	Engineering Statistics and Quality Control	9
39-310	Experiential Learning III	0
xx-xxx	General Education Course	9
		47

Spring		Units
12-353	Environmental Biology and Ecology	9
12-371	Advanced Computing and Problem Solving in Civil and Environmental Engineering	9
12-201	Geology	9
xx-xxx	Elective 2	6
xx-xxx	Elective 3	9
xx-xxx	General Education Course	9
		51

Senior Year

Fall		Units
12-401	CEE Design: Imagine, Build, Test	12
12-411	Project Management for Engineering and Construction	9
xx-xxx	General Education Course	9
xx-xxx	General Education Course	9
xx-xxx	General Education Course	9
		48

Spring		Units
12-451	Advanced Environmental Engineering	9
12-471	Applied Data Analytics for Civil and Environmental Systems	9
xx-xxx	Upper Level Environmental Engineering Elective	9
xx-xxx	Elective 4	9
xx-xxx	Elective 5	9
		45

Notes on Electives

1. **Students are encouraged to take multiple upper level courses to provide them with specific environmental engineering domain depth in their field(s) of interest.**

Specialty Areas in Civil Engineering

Students may select a set of civil engineering and other electives in the junior and senior years that enable them to concentrate in a specialty area, if they so desire. Some examples for grouping electives into specialty areas, together with representative course selections, are indicated below. Students can define other specialty area concentrations; discussion with a faculty mentor is encouraged. Specialty areas are not noted on the official transcript.

STRUCTURAL ENGINEERING

		Units
12-201	Geology	9
12-631	Structural Design	12
12-635	Structural Analysis	12
12-636	Geotechnical Engineering	9
21-241	Matrices and Linear Transformations	10
24-311	Numerical Methods	12
24-351	Dynamics	10

Computing in Civil Engineering

		Units
12-600	AutoCAD	3
12-623	Molecular Simulation of Materials	12
12-645	Smart Cities: Growth and Intelligent Transportation Systems	6
12-659	Special Topics: Matlab	6
24-451	Feedback Control Systems	12
24-650	Applied Finite Element Analysis	12
24-658	Image-Based Computational Modeling and Analysis	12

engineering and society

		Units
12-645	Smart Cities: Growth and Intelligent Transportation Systems	6
12-657	Water Resource Systems Engineering	9
24-291	Environmental Systems on a Changing Planet	9
48-371	City & Suburb: Housing in America after 1850	9
79-303	Pittsburgh and the Transformation of Modern Urban America	6
79-315	Thirsty Planet: The Politics of Water in Global Perspective	9

Construction Management

		Units
12-600	AutoCAD	3
12-631	Structural Design	12
12-635	Structural Analysis	12
12-636	Geotechnical Engineering	9
48-380	Real Estate for Architects	6
70-311	Organizational Behavior	9
70-321	Negotiation and Conflict Resolution	9

NEXT-GENERATION BUILDING AND CONSTRUCTION

		Units
12-631	Structural Design	12
39-245	Rapid Prototype Design	9
48-530	Human-Machine Virtuosity	12
48-555	Introduction to Architectural Robotics	9

SMART CITIES

		Units
12-600	AutoCAD	3
12-612	Intro to Sustainable Engineering	9
12-631	Structural Design	12
12-635	Structural Analysis	12
12-636	Geotechnical Engineering	9
12-644	Special Topics: Intro to Transportation Systems Analysis	6
12-645	Smart Cities: Growth and Intelligent Transportation Systems	6
24-643	Energy Storage Materials and Systems	12

SMART BUILDINGS

12-600	AutoCAD	3
12-631	Structural Design	12
12-635	Structural Analysis	12
48-116	Introduction to Building Performance	9
48-315	Environment I: Climate & Energy in Architecture	9
48-432	Environment II: Design Integration of Active Building Systems	9

MATERIALS

		Units
12-623	Molecular Simulation of Materials	12
24-643	Energy Storage Materials and Systems	12
27-201	Structure of Materials	9
27-202	Defects in Materials	9
27-215	Thermodynamics of Materials	12
27-301	Microstructure and Properties I	9

27-406	Sustainable Materials	9
27-503	Additive Manufacturing and Materials	9

Specialty Areas in Environmental Engineering

ENVIRONMENTAL ENGINEERING - WATER QUALITY

		Units
09-106	Modern Chemistry II	10
09-510	Chemistry and Sustainability	9
12-612	Intro to Sustainable Engineering	9
12-629	Environmental Microbiology for Engineers	9
12-657	Water Resource Systems Engineering	9

ENGINEERING AND SOCIETY

		Units
12-645	Smart Cities: Growth and Intelligent Transportation Systems	6
12-657	Water Resource Systems Engineering	9
24-291	Environmental Systems on a Changing Planet	9
48-371	City & Suburb: Housing in America after 1850	9
79-303	Pittsburgh and the Transformation of Modern Urban America	6
79-315	Thirsty Planet: The Politics of Water in Global Perspective	9

ENVIRONMENTAL ENGINEERING - ENERGY

		Units
09-106	Modern Chemistry II	10
12-612	Intro to Sustainable Engineering	9
24-424	Energy and the Environment	9
24-292	Renewable Energy Engineering	9
24-628	Energy Transport and Conversion at the Nanoscale	12

ENVIRONMENTAL ENGINEERING - AIR QUALITY

		Units
09-106	Modern Chemistry II	10
09-510	Chemistry and Sustainability	9
12-612	Intro to Sustainable Engineering	9
12-651	Air Quality Engineering	9
24-425	Combustion and Air Pollution Control	9

Additional Majors and Minors

Civil Engineering and Environmental Engineering students may pursue additional majors and minors in a variety of subjects, taking advantage of the free elective courses to satisfy the requirements for the major or minor. The College of Engineering has designated minors to promote flexibility and diversity among engineering students. Many Civil Engineering and Environmental Engineering undergraduates pursue designated minors in areas such as Architecture, Environmental and Sustainability Studies, or Global Engineering.

Internships and Co-Operative Education Program

Students in Civil Engineering and Environmental Engineering are encouraged to undertake professional internships during summer breaks. In addition, a cooperative internship program is possible for either Jan-Aug or May-Dec in the junior year. Students undertaking these 8-month professional internships would ordinarily graduate after an additional semester of study.

Integrated B.S./M.S. Program

Interested undergraduates may plan a course of study that leads to either the B.S. in Civil Engineering or the B.S. in Environmental Engineering as well as the M.S. in Civil and Environmental Engineering. This course of study will ordinarily require ten semesters, although advanced placement or other study may reduce this time. In the ninth semester of study, students must register in graduate status. Interested students should consult the Director of Undergraduate Programs for information about admission to the M.S. program.

Faculty

AMIT ACHARYA, Professor of Civil and Environmental Engineering – Ph.D., University of Illinois at Urbana - Champaign; Carnegie Mellon, 2000–

PETER ADAMS, Thomas Lord Professor of Engineering, Civil and Environmental Engineering and Engineering and Public Policy; Department Head of Engineering and Public Policy – PhD., California Institute of Technology; Carnegie Mellon, 2001–

BURCU AKINCI, Department Head and Paul P. Christiano Professor of Civil and Environmental Engineering – Ph.D., Stanford University; Carnegie Mellon, 2000–

MARIO BERGES, Professor of Civil and Environmental Engineering – Ph.D., Carnegie Mellon Univesity; Carnegie Mellon, 2010–

JACOBO BIELAK, P.E., Hamerschlag University Professor Emeritus of Civil and Environmental Engineering – Ph.D., California Institute of Technology, , P.E.; Carnegie Mellon, 1978–

SARAH J. CHRISTIAN, P.E., Associate Teaching Professor of Civil and Environmental Engineering – Ph.D., Stanford; Carnegie Mellon, 2015–

JARED L. COHON, President Emeritus, Carnegie Mellon University, University Professor of Civil and Environmental Engineering and Engineering and Public Policy – Ph.D., Massachusetts Institute of Technology, P.E.; Carnegie Mellon, 1997–

KAUSHIK DAYAL, Professor of Civil and Environmental Engineering – Ph.D., California Institute of Technology; Carnegie Mellon, 2008–

DAVID A. DZOMBAK, P.E., Hamerschlag University Professor Emeritus of Civil and Environmental Engineering – Ph.D., Massachusetts Institute of Technology, P.E.; Carnegie Mellon, 1989–

SARAH FAKHREDDINE, Assistant Professor of Civil and Environmental Engineering – PhD, Stanford; Carnegie Mellon, 2022–

SUSAN FINGER, Professor of Civil and Environmental Engineering; Associate Dean, Integrative Design Arts & Technology (IDeATe) – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1989–

KATHERINE A. FLANIGAN, Assistant Professor of Civil and Environmental Engineering – PhD, University of Michigan; Carnegie Mellon, 2020–

JAMES H. GARRETT, JR. P.E., Provost – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1990–

KELVIN GREGORY, Professor and Executive Director of Undergraduate and Graduate Programs, Civil and Environmental Engineering – Ph.D., University of Iowa; Carnegie Mellon, 2006–

COREY HARPER, Assistant Professor of Civil and Environmental Engineering and Heinz College – PhD, Carnegie Mellon University; Carnegie Mellon, 2021–

CHRIS T. HENDRICKSON, Hamerschlag University Professor Emeritus of Civil and Environmental Engineering – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1978–

GREGORY LOWRY, Walter J. Blenko, Sr. Professor of Civil and Environmental Engineering – Ph.D., Stanford University; Carnegie Mellon, 2002–

JOE MOORE, Assistant Teaching Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2017–

DESTENIE NOCK, Assistant Professor of Civil and Environmental Engineering and Engineering and Public Policy – PhD, University of Massachusetts, Amherst; Carnegie Mellon, 2019–

FETHIYE OZIS, P.E., Assistant Teaching Professor of Civil and Environmental Engineering – PhD, University of Southern California; Carnegie Mellon, 2022–

MATTEO POZZI, Professor of Civil and Environmental Engineering – Ph.D., University of Trento, Italy; Carnegie Mellon, 2012–

ZHEN (SEAN) QIAN, Professor of Civil and Environmental Engineering – Ph.D., University of California, Davis; Carnegie Mellon, 2015–

DAVID ROUNCE, Assistant Professor of Civil and Environmental Engineering – PhD, University of Texas at Austin; Carnegie Mellon, 2020–

CONSTANTINE SAMARAS, Professor of Civil and Environmental Engineering – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2014–

MITCHELL J. SMALL, H. John Heinz Professor Emeritus of Civil and Environmental Engineering and Engineering and Public Policy – Ph.D., University of Michigan; Carnegie Mellon, 1982–

PINGBO TANG, Associate Professor of Civil and Environmental Engineering – PhD, Carnegie Mellon University; Carnegie Mellon, 2020–

JEANNE VANBRIESEN, P.E., Duquesne Light Company Professor of Civil and Environmental Engineering and Engineering and Public Policy; Vice Provost for Faculty – Ph.D., Northwestern University; Carnegie Mellon, 1999–

GERALD J. WANG, Assistant Professor of Civil and Environmental Engineering – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2019–