Department of Civil and Environmental Engineering

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 who are 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 who are 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 solutions to local and global problems; graduates are able to cross geographic, cultural, and traditional discipline boundaries in developing solutions.

The undergraduate 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.

Curriculum

Minimum units required for B.S. in Civil Engineering 385

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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>09-101</td>
<td>Introduction to Experimental Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>09-105</td>
<td>Introduction to Modern Chemistry I</td>
<td>10</td>
</tr>
<tr>
<td>15-110</td>
<td>Principles of Computing</td>
<td>10</td>
</tr>
<tr>
<td>21-120</td>
<td>Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>21-122</td>
<td>Integration and Approximation</td>
<td>10</td>
</tr>
<tr>
<td>21-259</td>
<td>Calculus in Three Dimensions</td>
<td>9</td>
</tr>
<tr>
<td>21-260</td>
<td>Differential Equations</td>
<td>9</td>
</tr>
<tr>
<td>33-141</td>
<td>Physics I for Engineering Students</td>
<td>12</td>
</tr>
<tr>
<td>33-142</td>
<td>Physics II for Engineering and Physics Students</td>
<td>12</td>
</tr>
</tbody>
</table>

Department of Civil and Environmental Engineering

David A. Dzombak, Head
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, and operate infrastructure used daily by the public and industry, such as buildings, transportation networks, water systems, and energy distribution systems. Civil engineers also work to protect public health and the environment. They work at the intersection of the built, natural, and information environments. 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.

Civil and environmental engineering requires broad technical training and faculty members, emphasize the complexity of large projects, and the interactions with engineers in other fields, lawyers, public officials, community members, and other stakeholders. Our curriculum provides this versatility for professional practice in civil and environmental engineering and as a strong foundation for other professional pursuits.

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. While maintaining its emphasis on the fundamental understanding of the behavior of constructed facilities through the application of the physical sciences, biology, mathematics, and computing, the curriculum has continually evolved in directions that exploit advances in technology. The curriculum introduces the methods of engineering design in the first year and continues to emphasize them throughout the curriculum in both traditional and project-oriented courses. The basic undergraduate degree program leads to a B.S. in Civil Engineering. A minor in Environmental and Sustainability Studies is also available.

Central to the evolution of technology and its impact on engineering practice is the modern emphasis on the use of computers in engineering. Several courses on computer methods are required in the curriculum, and most courses offered by the department require the use of computers in applications of either analysis or design.

Our curriculum emphasizes 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, or environmental engineering, this approach to teaching allows application of the most advanced technological developments. Others 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.

The Civil Engineering curriculum is intended to allow many opportunities for students to pursue areas of personal interest. A student may choose to concentrate in a specialty area in civil engineering, to pursue a minor in one of the designated minor programs offered in the College of Engineering or elsewhere in the university, or to pursue an additional major. Information on these options follows the description of the curriculum in this section. Students are encouraged to participate in research with department faculty members, explore their chosen field through internships, and apply science and technology to develop sustainable solutions to local and global problems; graduates are able to cross geographic, cultural, and traditional discipline boundaries in developing solutions.

The Civil Engineering curriculum is intended to allow many opportunities for students to pursue areas of personal interest. A student may choose to concentrate in a specialty area in civil engineering, to pursue a minor in one of the designated minor programs offered in the College of Engineering or elsewhere in the university, or to pursue an additional major. Information on these options follows the description of the curriculum in this section. Students are encouraged to participate in research with department faculty members, explore their chosen field through internships, and apply science and technology to develop sustainable solutions to local and global problems; graduates are able to cross geographic, cultural, and traditional discipline boundaries in developing solutions.

Graduates are innovative, proactive, and adaptive professionals who are 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 solutions to local and global problems; graduates are able to cross geographic, cultural, and traditional discipline boundaries in developing solutions.

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.
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 prerequisite 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
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

Spring
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

Sophomore Year
Fall
12-200 CEE Challenges: Design in a Changing World 9
12-212 Statics 9
21-259 Calculus in Three Dimensions 9
15-110 Principles of Computing 10
xx-xxx General Education Course 9
39-210 Experiential Learning I 0

Spring
12-231 Solid Mechanics 9
12-232 Solid Mechanics Lab 3
12-271 Introduction to Computer Application in Civil & Environmental Engineering 9
21-260 Differential Equations 9
09-105 Introduction to Modern Chemistry I 10
xx-xxx General Education Course 9
39-220 Experiential Learning II 0

Junior Year
Fall
12-301 CEE Projects: Designing the Built, Natural and Information Environments 9
12-335 Soil Mechanics 9
12-336 Soil Mechanics Laboratory 3
12-355 Fluid Mechanics 9
12-356 Fluid Mechanics Lab 3
36-220 Engineering Statistics and Quality Control 9
xx-xxx Elective 1 9
39-310 Experiential Learning III 0

Spring
12-351 Environmental Engineering 9

Senior Year
Fall
12-401 CEE Design: Imagine, Build, Test 12
12-411 Project Management for Construction 9
12-421 Engineering Economics 6
xx-xxx General Education Course 9
xx-xxx Elective 4 9

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
   - 12-203 Special Topics: Ecology 9
   Substitutions may be made only with the approval of the Department Head.

2. One elective course is restricted to a 600-level Civil Engineering course of at least 9 units, except 12-648 and 12-690. This Civil Engineering elective is a co-requisite for 12-401. The combination of 12-606 and 12-645 may also be used, but no other combination is allowed.
3. Students are encouraged to take multiple 12-6xx courses to provide them with specific civil and 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

Environmental Engineering - Air Quality
### Environmental Engineering - Water Quality

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-121</td>
<td>Modern Biology</td>
<td>9</td>
</tr>
<tr>
<td>09-106</td>
<td>Modern Chemistry II</td>
<td>10</td>
</tr>
<tr>
<td>09-510</td>
<td>Chemistry and Sustainability</td>
<td>9</td>
</tr>
<tr>
<td>12-612</td>
<td>Intro to Sustainable Engineering</td>
<td>9</td>
</tr>
<tr>
<td>12-629</td>
<td>Environmental Microbiology for Engineers</td>
<td>9</td>
</tr>
<tr>
<td>12-657</td>
<td>Water Resource Systems Engineering</td>
<td>9</td>
</tr>
</tbody>
</table>

### Environmental Engineering - Energy

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>06-221</td>
<td>Thermodynamics</td>
<td>9</td>
</tr>
<tr>
<td>09-106</td>
<td>Modern Chemistry II</td>
<td>10</td>
</tr>
<tr>
<td>12-350</td>
<td>Solar Decathlon Systems Design</td>
<td>9</td>
</tr>
<tr>
<td>12-612</td>
<td>Intro to Sustainable Engineering</td>
<td>9</td>
</tr>
<tr>
<td>24-424</td>
<td>Energy and the Environment</td>
<td>9</td>
</tr>
<tr>
<td>24-292</td>
<td>Renewable Energy Engineering</td>
<td>9</td>
</tr>
<tr>
<td>24-628</td>
<td>Energy Transport and Conversion at the Nanoscale</td>
<td>12</td>
</tr>
</tbody>
</table>

### Computing in Civil Engineering

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-600</td>
<td>AutoCAD</td>
<td>3</td>
</tr>
<tr>
<td>12-623</td>
<td>Molecular Simulation of Materials</td>
<td>12</td>
</tr>
<tr>
<td>12-645</td>
<td>Smart Cities: Growth and Intelligent Transportation Systems</td>
<td>6</td>
</tr>
<tr>
<td>12-659</td>
<td>Special Topics: Matlab</td>
<td>6</td>
</tr>
<tr>
<td>24-451</td>
<td>Feedback Control Systems</td>
<td>12</td>
</tr>
<tr>
<td>24-650</td>
<td>Applied Finite Element Analysis</td>
<td>12</td>
</tr>
<tr>
<td>24-658</td>
<td>Image-Based Computational Modeling and Analysis</td>
<td>12</td>
</tr>
</tbody>
</table>

### Environmental Engineering - Energy

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-645</td>
<td>Smart Cities: Growth and Intelligent Transportation Systems</td>
<td>6</td>
</tr>
<tr>
<td>19-437</td>
<td>Special Topics: Global Ecological Issues &amp; Controversies</td>
<td>9</td>
</tr>
<tr>
<td>24-291</td>
<td>Special Topics: Environmental Systems on a Changing Planet</td>
<td>9</td>
</tr>
<tr>
<td>48-371</td>
<td>American House and Housing, 1850-1975</td>
<td>9</td>
</tr>
<tr>
<td>79-303</td>
<td>Pittsburgh and the Transformation of Modern Urban America</td>
<td>6</td>
</tr>
<tr>
<td>79-315</td>
<td>Thirsty Planet: The Politics of Water in Global Perspective</td>
<td>9</td>
</tr>
<tr>
<td>79-397</td>
<td>Environmental and Public Health Crises in the City</td>
<td>6</td>
</tr>
</tbody>
</table>

### Construction Management

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-600</td>
<td>AutoCAD</td>
<td>3</td>
</tr>
<tr>
<td>12-631</td>
<td>Structural Design</td>
<td>12</td>
</tr>
<tr>
<td>12-635</td>
<td>Structural Analysis</td>
<td>12</td>
</tr>
<tr>
<td>12-636</td>
<td>Geotechnical Engineering</td>
<td>9</td>
</tr>
<tr>
<td>48-380</td>
<td>Real Estate Design and Development</td>
<td>6</td>
</tr>
<tr>
<td>70-311</td>
<td>Organizational Behavior</td>
<td>9</td>
</tr>
<tr>
<td>70-321</td>
<td>Negotiation and Conflict Resolution</td>
<td>9</td>
</tr>
</tbody>
</table>

### Integrated B.S./M.S. Program

**Description:**

Integrated B.S./M.S. program allows students to earn both the B.S. in Civil Engineering and the M.S. in Civil and Environmental Engineering in five years. This is ideal for students who are planning to pursue careers that require advanced knowledge in civil engineering and environmental science. The program offers a unique opportunity to gain hands-on experience through internships and research opportunities. Students are required to complete a thesis or a comprehensive examination as part of their M.S. program. The program emphasizes interdisciplinary collaboration and prepares students for leadership roles in the engineering field.

### Additional Majors and Minors

Civil 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 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 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.

### Faculty

AMIT ACHARYA, Professor of Civil and Environmental Engineering – Ph.D., University of Illinois at Urbana - Champaign; Carnegie Mellon, 2000-
PETER ADAMS, Professor of 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, 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 University; 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., Assistant 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., Department Head and Hamerschlag University Professor of Civil and Environmental Engineering – Ph.D., Massachusetts Institute of Technology, P.E.; Carnegie Mellon, 1989-

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 of Civil and Environmental Engineering – Ph.D., University of Iowa; Carnegie Mellon, 2006-

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., University of Illinois; Carnegie Mellon, 2002-

H. SCOTT MATTHEWS, Professor of Civil and Environmental Engineering – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2001-

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

IRVING J. OPPENHEIM, P.E., Professor of Civil and Environmental Engineering and Architecture – Ph.D., Cambridge University, P.E.; Carnegie Mellon, 1972-

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

ZHEN (SEAN) QIAN, Henry Posner, Anne Molloy, and Robert and Christine Pietrandrea Associate 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, Associate Professor of Civil and Environmental Engineering – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2014-

MITCHELL J. SMALL, H. John Heinz Professor 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-