

Civil and Environmental Engineering

The George R. Brown School of Engineering

Chair

Joseph B. Hughes

Professors

Philip B. Bedient
 Ahmad J. Durrani
 Arthur A. Few, Jr.
 Joseph B. Hughes
 Mason B. Tomson
 Pol D. Spanos
 Anestis S. Veletsos
 Calvin H. Ward
 Mark R. Wiesner
Professors Emeriti
 Ronald P. Nordgren
 John E. Merwin

Associate Professors

Panos Dakoulas
 Satish Nagarajaiah
Assistant Professors
 Matthew P. Fraser
 Michael Terk
Adjunct Professors
 James B. Blackburn
 Jean-Yves Bottero
 Carroll Oubre
**Adjunct Assistant
 Professor**
 Charles J. Newell

Lecturers

Milton Hanks
 Moyeen Haque
 Sergios Liapis
 John E. Merwin
 Pat H. Moore
 James Murtha
 John M. Sedlak
 Ed Segner, III
 Taqir Sheikh
 Christof Spieler

Degrees Offered: B.A., B.S.C.E., M.C.E., M.E.E., M.E.S., M.S., Ph.D.

Civil and Environmental Engineering (C&EE) is a broad and diverse field of study that offers students an education with several degree options. The most flexible degree options are at the bachelor's level, where students can major in civil engineering or complete a double major with any other Rice University major. The double major has two tracks, one in environmental engineering sciences (EES), and the other in environmental sciences (ES). For students desiring an accredited professional degree, the B.S.C.E. is offered with sub-specialization in one of three areas of concentration: structural engineering, environmental engineering, or engineering management. Three nonthesis graduate degrees (M.C.E., M.E.E., and M.E.S) are available to students who desire additional education and specialization in civil engineering, environmental engineering, or environmental sciences. Joint M.B.A./Master of Engineering degrees are also available in conjunction with the Jesse H. Jones Graduate School of Management.

Students admitted for graduate study leading to M.S. or Ph.D. degrees must complete a rigorous course of study that combines advanced course work with scholarly research culminating in the public defense of a written thesis. Graduate research is carried out in a range of areas reflecting the interests of the department's faculty. Examples include structural engineering and mechanics, earthquake engineering, geotechnical engineering, computer-aided design, hydrology, water resources and water quality engineering, air pollution and its control, and hazardous waste treatment.

Degree Requirements for B.S.C.E. in Civil Engineering

The B.S.C.E. degree is a professional degree accredited by the Accreditation Board for Engineering and Technology (ABET). Students in the B.S. program may choose among the three specialization options as follows:

- structural engineering
- environmental engineering
- engineering management

For the B.S.C.E. degree, students must have a total of at least 134 semester hours at graduation, including the following required courses:

General Science (39 hours)

MATH 101 *Single Variable Calculus I*
 MATH 102 *Single Variable Calculus II*
 CHEM 121 *General Chemistry with Laboratory*
 CHEM 122 *General Chemistry with Laboratory*
 PHYS 101 *Mechanics with Laboratory*
 PHYS 102 *Electricity and Magnetism with Laboratory*
 MATH 211 *Ordinary Differential Equations and Linear Algebra*
 MATH 212 *Multivariable Calculus*
 CAAM 210 or CAAM 211 *Introduction to Engineering Computation*
 STAT 310 *Probability and Statistics*
 CAAM 335 *Matrix Analysis*—or equivalent

1 of the following:

CHEM 211 *Organic Chemistry*
 or PHYS 201 *Waves and Optics*
 or BIOS 201 *Introductory Biology*

Core Engineering (41 Hours)

CIVI 211 *Engineering Mechanics*
 CIVI 300 *Mechanics of Solids I*
 CIVI 302 *Strength of Materials Laboratory*
 CIVI 304 *Structural Analysis I*
 CIVI 306 *Steel Design*
 CIVI 363 *Applied Fluid Mechanics*
 ENVI 403 *Principles of Environmental Engineering*
 CIVI 403 *Reinforced Concrete Design*
 CIVI 404 *Reinforced Concrete Laboratory*
 ENVI 412 *Hydrology and Watershed Analysis*
 CIVI 451 *Introduction to Transportation*
 CIVI 470 *Basic Soil Mechanics*
 CIVI 480 *Senior Design Project*
 CIVI 479 *Introduction to Project Development*
 ENVI 512 *Hydrology Design Laboratory*

1 of the following:

MSCI 301 *Materials Science*
 or ELEC 243 *Introduction to Electronics*
 or MECH 200 *Classical Thermodynamics*
 or COMP 260 *Visual Methods for Science and Engineering*
 or any other approved elective

Structural Engineering Option: (12 hours)

CIVI 570 *Foundation Engineering*
 CIVI 305 *Structural Analysis II*
 CIVI 400 *Mechanics of Solids II*
 500 Level Approved Elective

Environmental Engineering Option: (12 hours)

ENVI 306 *Global Environmental Law and Sustainable Development*
 or any other approved ENVI course
 ENVI 411 *Air Resource Management*
 ENVI 434 *Chemical Transport and Fate in the Environment*
 500 Level Approved Elective

Engineering Management Option: (12 hours)

CIVI 322 *Engineering Economics and Management*
 ACCO 305 *Introduction into Accounting*
 or any other approved MGMT course
 CAAM 376 *Introduction to Management Science*
 500 Level Approved Elective

Recommended Electives: (12 hours)

ENGI 302 *Ethical Decision-making for Engineers*
 ENGI 321 *The Professional Engineer: Roles and Responsibilities*
 CIVI 201 *Civil Engineers and the World We Build*
 ENVI 201 *Introduction to Environmental Systems*
 CIVI 251 *Plane Surveying*

See Civil Engineering website for a complete list.

Required Courses:	80 hours
Specialization Option:	12 hours
Free Electives:	18 hours
University Distribution:	24 hours
B.S. Civil Engineering Requirement:	134 hours

Degree Requirements for B.A. in Civil Engineering

For general university requirements, see Graduation Requirements (pages 16–18). For the **B.A.** degree, students majoring in civil engineering must have a total of at least 120 semester hours at graduation. The B.A. is not accredited as a professional degree; detailed requirements are available from the department office.

Degree Requirements for B.A. in Environmental Science and Engineering (as a double major)

The Department of Civil and Environmental Engineering offers the **B.A.** as a double major with any other major at Rice University. The double major has two tracks, one in environmental engineering sciences (EES), and one in environmental sciences (ES). Faculty from the Wiess School of Natural Sciences work with C&EE faculty in offering courses, advising, and administering the ES track of this double major. The double major is designed to accommodate:

- Students wishing to obtain a solid preparation for later graduate study in environmental engineering, environmental science, or other careers as environmental professionals (e.g., environmental economics or environmental law), and
- Students pursuing nonenvironmental careers (e.g., historians, lawyers, mechanical engineers, chemists) who will nonetheless benefit from a knowledge of the environmental dimensions of problems and issues they will confront.

The 68-semester-hour (minimum) double major in environmental science and engineering may be taken in conjunction with *any* stand-alone major offered in any school of the university. The EES track is highly recommended for students wishing to pursue graduate study in environmental engineering. Students wishing to obtain an ABET-accredited degree in engineering should pursue the environmental specialization within the B.S.C.E. or through a similar offering provided by the Department of Chemical Engineering. Students choosing the ES track are encouraged to select one of the following participating faculty members from the Wiess School of Natural Sciences as their adviser:

John Anderson (*Earth Science*)

Andre Droxler (*Earth Science*)

Arthur Few (*Physics and Astronomy and Environmental Science*)

F. M. Fisher (*Ecology and Evolutionary Biology*)

P. A. Harcombe (*Ecology and Evolutionary Biology*)

William Leeman (*Earth Science*)

D. Queller (*Ecology and Evolutionary Biology*)

R. L. Sass (*Ecology and Evolutionary Biology*)

Dale Sawyer (*Earth Science*)

J. E. Strassmann (*Ecology and Evolutionary Biology*)

A. Thornhill (*Ecology and Evolutionary Biology*)

The key components of the double major include:

- Foundation course work in mathematics, physics, chemistry, and biology required in both tracks.
- A set of 5 undergraduate core courses, required of all double majors, that acquaint undergraduates with a range of environmental problems encountered by scientists, engineers, managers, and policy makers. Core courses in the EES track cover the breadth of water, soil, and air media within the context of engineering technologies and approaches to problem solving, and stress quantitative analytical tools used to address environmental problems. Core courses in the ES track stress the components of the global environment and their interactions.

- 24 semester hours of environmental electives, in both tracks, from four categories: (1) social sciences and business, (2) humanities and architecture, (3) natural sciences, and (4) engineering. Students may petition to have electives, in addition to those currently listed, apply toward the double major.

Specific Course Requirements for a Double Major (B.A.) in Environmental Science and Engineering include:

General Prerequisites

CHEM 121 or 151 *General Chemistry with Laboratory*
 CHEM 122 or 152 *General Chemistry with Laboratory*
 MATH 101 *Single Variable Calculus I*
 MATH 102 *Single Variable Calculus II*
 PHYS 101 or 125 or 111 *Mechanics*
 PHYS 102 or 126 or 112 *Electricity and Magnetism*
 BIOS 201 *Introductory Biology*
 BIOS 202 *Introductory Biology*
 (Environmental sciences track only)

1 of the following 2 courses:

NSCI 230 *Computation in Natural Science*
 (Environmental sciences track only)
 MATH 211 *Ordinary Differential Equations and Linear Algebra*
 (Environmental engineering sciences track only)

Core Courses: Environmental Sciences Track

BIOS 325 *Ecology*
 GEOL 326 *Environmental Geology*
 PHYS 443 *Atmospheric Science*
 (or ENVI 411 *Air Resource Management*)

2 of the following 3 courses:

ENVI 401 *Introduction to Environmental Chemistry*
 ENVI 412 *Hydrology and Watershed Analysis*
 GEOL 451 *Analysis of Environmental Data*

Core Courses: Environmental Engineering Sciences Track

ENVI 401 *Introduction to Environmental Chemistry*
 ENVI 403 *Principles of Environmental Engineering*
 ENVI 411 *Air Resource Management*
 ENVI 412 *Hydrology and Watershed Analysis*
 ENVI 434 *Chemical Transport and Fate in the Environment*

Sample Curriculum in the Environmental Engineering Sciences Track

Freshman Year

Fall

MATH 101 *Single Variable Calculus I*
 PHYS 101 *Mechanics*
 CHEM 121 *General Chemistry with Laboratory*
 Electives
 HPER 101

Spring

MATH 102 *Single Variable Calculus II*
 PHYS 102 *Electricity and Magnetism*
 CHEM 122 *General Chemistry with Laboratory*
 Electives
 HPER 102

Sophomore Year

Fall

MATH 211 *Ordinary Differential Equations*
 BIOS 201 *Introductory Biology*
 Environmental Elective*
 Environmental Elective

Spring

Environmental Elective
 Environmental Elective

*ENVI 201 *Introduction to Environmental Systems* recommended as environmental elective

Junior Year**Fall**

ENVI 401 *Introduction to Environmental Chemistry*
 Environmental Elective
 Environmental Elective

Spring

ENVI 411 *Air Resource Management*

Senior Year**Fall**

ENVI 403 *Principles of Environmental Engineering*
 ENVI 434 *Chemical Transport and Fate in the Environment*
 Environmental Elective

Spring

ENVI 412 *Hydrology and Watershed Analysis*
 Environmental Elective

24 semester hours of environmental electives are required, with at least 6 semester hours of course work from each of four categories. Consult the faculty adviser or Department of Environmental Science and Engineering for a list of approved electives.

Sample Curriculum in Environmental Sciences Track**Freshman Year****Fall**

MATH 101 *Single Variable Calculus I*
 PHYS 101 *Mechanics*
 CHEM 121 *General Chemistry with Laboratory*
 Electives
 HPER 101

Spring

MATH 102 *Single Variable Calculus II*
 PHYS 102 *Electricity and Magnetism*
 CHEM 122 *General Chemistry with Laboratory*
 Electives
 HPER 102

Junior Year**Fall**

BIOS 325 *Ecology*
 GEOL 326 *Environmental Geology*
 Environmental Elective

Spring

PHYS 443 *Atmospheric Science*
 or ENVI 411 *Air Resource Management*
 Environmental Elective

Sophomore Year**Fall**

NSCI 230 *Computation in the Natural Sciences*
 BIOS 201 *Introductory Biology*
 Environmental Elective
 Environmental Elective

Spring

BIOS 202 *Introductory Biology*
 Environmental Elective
 Environmental Elective

Senior Year**Fall**

GEOL 451 *Analysis of Environmental Data* or ENVI 401 *Introduction to Environmental Chemistry*
 Environmental Elective
 Environmental Elective

Spring

ENVI 412 *Hydrology and Watershed Analysis*

24 semester hours of environmental electives are required, with at least 6 semester hours of course work from each of four categories. Consult the faculty adviser or Department of Environmental Science and Engineering for a list of approved electives.

Degree Requirements for M.C.E., M.E.E., M.E.S., M.S., and Ph.D.

Admission. Applicants pursuing graduate education in structural engineering, structural mechanics, and geotechnical engineering should have a B.S.C.E. with a significant emphasis on structural engineering, but students with other undergraduate degrees may apply if they have adequate preparation in mathematics, mechanics, and structural analysis and design. Courses such as engineering technology or construction technology, however, do not represent adequate preparation. Applicants for the M.E.E. and the M.E.S. must have a B.S. or B.A. in related areas of science and engineering. Successful applicants typically have at least a 3.00 (B) grade point average in undergraduate work and high Graduate Record Examination (GRE) scores. For general university requirements, see Graduate Degrees and Admission to Graduate Study.

M.C.E. Program. The Master of Civil Engineering (M.C.E.) is a professional nonthesis degree requiring 30 hours of study. Students with a B.S. in Civil Engineering are eligible to apply. Areas of study include structural dynamics, offshore technology, reinforced concrete and prestressed concrete, reliability of systems, random vibrations, soil dynamics, soil-structure interaction, and structural control. For general university requirements, see Graduate Degrees. To earn a M.C.E. degree, students must:

- Complete 30 semester hours of approved courses

M.B.A./M.C.E. Program. For general university requirements, see Graduate Degrees. See also Accounting and Management. To earn a M.B.A./M.C.E. degree, students must:

- Complete 24 semester hours of civil engineering courses
- Complete 52 semester hours of business administration courses

M.E.E. Program. The Master of Environmental Engineering (M.E.E.) is a professional nonthesis degree requiring 30 hours of study. Students who have a B.S. degree in any field of engineering may apply. Areas of study include hydrology and water resources engineering, water treatment, water chemistry, air pollution and its control, and hazardous waste treatment. Although the program is open to all qualified applicants, candidates usually are completing undergraduate programs in environmental engineering and wish to extend their education into a fifth year of specialized study.

M.E.S. Program. The Master of Environmental Science (M.E.S.) is a professional nonthesis degree requiring 30 hours of study. To enter the M.E.S. program, applicants must have a B.A. or B.S. degree in any of the natural or physical sciences. Areas of study include hydrology and water resources engineering, water treatment, water chemistry, air pollution and its control, and hazardous waste treatment. Although the program is open to all qualified applicants, candidates typically are completing undergraduate programs in environmental science and wish to extend their education into a fifth year of specialized study.

M.S. Program. The Master of Science degree is offered in both Civil Engineering and Environmental Engineering. For general university requirements, see Graduate Degrees (pages 60–65). To earn a M.S. degree, students must:

- Complete at least 24 semester hours of approved courses. For students studying Environmental Engineering this must include one course each in environmental chemistry, water treatment, hydrology, and air quality (comparable course work completed previously may be substituted for the core courses)
- Select a thesis committee according to department requirements and conduct original research in consultation with the committee
- Present and defend in oral examination an approved research thesis

Students take the oral exam only after the committee determines the thesis to be in an acceptable written format for public defense. Normally, students take two academic years and the intervening summer to complete the degree.

Students intending to extend their studies into the Ph.D. degree program should note that the department does not grant an automatic M.S. degree to candidates who have not written a satisfactory master's thesis.

Ph.D. Program in Civil Engineering. For general university requirements, see Graduate Degrees (pages 60–65). To earn a Ph.D. degree in Civil Engineering, students must:

- Complete at least 48 semester hours of approved courses with high standing
- Pass a comprehensive preliminary examination testing the candidate's knowledge of the field and ability to think in a creative manner
- Pass an oral qualifying examination on the proposed thesis research and related topics
- Complete a thesis that constitutes an original contribution to knowledge
- Pass a final public oral examination on the thesis and related topics

Ph.D. Program in Environmental Engineering. To earn a Ph.D. degree in environmental engineering sciences, candidates must successfully accomplish the following (spending at least four semesters in full-time study at Rice):

- Complete 90 semester hours of approved course work with high standing
- Pass a preliminary written examination on the field of environmental engineering sciences
- Pass a qualifying examination on course work, proposed research, and related topics
- Complete a dissertation indicating an ability to do original and scholarly research
- Pass a formal public oral examination on the thesis and related topics

Ph.D. candidates in environmental engineering sciences take the preliminary exam, administered by department faculty, after two semesters of course work. Candidates who pass this exam then form a doctoral committee according to department requirements. The qualifying examination administered by the doctoral committee after candidates develop a research proposal evaluates their preparation for the proposed research and identifies any areas requiring additional course work or study.

See CIVI (pages 294–298) and ENVI (pages 345–347) in the Courses of Instruction section.