McCormick

Northwestern Engineering

Environmental Engineering

Bachelor of Science—BSEE—2010-2011

Civil and Environmental Engineering Department

www.civil.northwestern.edu

If you are declaring Environmental Engineering as your Major,
contact Janet Soule, CEE's Academic Coordinator, to find your new advisor!

j-soule@northwestern.edu

Environmental Engineers stand at the threshold between natural environmental systems and human societies!

Environmental engineers are the technical professionals who identify and design solutions for environmental problems. They seek to shield the environment from the harmful effects of human activity, protect human populations from adverse environmental events such as floods and disease, and restore environmental quality for ecological and human well-being. Traditionally, environmental engineers provided safe drinking water, treated and properly disposed of wastes, maintained air quality, controlled water pollution, and remediated sites contaminated by hazardous substances. They continue to do these activities as well as monitor the quality of the air, water, and land and develop new, improved environmental control technologies.

Although many people are concerned about the state of our environment, environmental engineers understand how complicated environmental systems work. They develop molecular tools to track contaminants at very low levels in complex mixtures and genomic tools to characterize microbial diversity in unknown communities. Environmental engineers are the vital link between scientific discovery, technological development and the societal need for protecting human health and ecological integrity. More and more the emphasis of their work is shifting from managing wastes after they are generated, to altering production processes so to recover, recycle and reuse resources.

Historically, it was the sanitary and civil engineer who made cities livable for large populations. A crucial future need is to find ways to make both developing and post-industrial cities **sustainable**. Environmental engineers will be critical members of manufacturing teams where the design and production of goods are developed in full consideration of their environmental impacts during production, use and at the end of their useful life. Environmental engineers are working to improve energy efficiency in infrastructure design, enhance the development of renewable energy and restore the full services of ecosystems so there is less reliance on technology.

The field of environmental engineering, as well as environmental engineering education, is highly interdisciplinary. They involve traditional components such as mathematics, physics, chemistry, and engineering design. But, environmental engineering education also includes a range of other disciplines, including biology, microbiology, ecology, public health, material science, geology, meteorology, economics, political science, and computer science. To address the spectrum of issues facing the environment, environmental engineers are broadly educated, as well as technically trained.

So, You Want to be an Environmental Engineer
Association of Environmental Engineering and Science Professors

–––– BSEE — Civil and Environmental Engineering departmental program ––––

Undergraduate Curriculum – Total requirement = 48 courses, 18 of which must be Engineering.

Mathematics - 4 courses	
MATH 220, 224, 230	Calculus I, II, III
MATH 234	Multiple Integration and Vector Calculus
Basic Sciences - 4 courses	
CHEM 101, 102, 103 or CHEM 171/172 (Equivalent to CHEM 101/102/103) PHYSICS 135-2 (Recommended to complete PHYS 135-3 as an unrestricted elective)	**General**: Chemistry, Inorganic Chemistry, Phys Chemistry or **Accelerated General**: Inorganic Chemistry, Phys Chemistry General Physics
Engineering Analysis and Computer Proficiency - 4 courses	
GEN_ENG 205-1, 2, 3, 4	Engineering Analysis
Design and Communication - 3 course units	
IDEA 106-1,2 (0.5 units each) and English 106-1,2 (0.5 units each); and One course from the following (1.0 units each) Speech 102 or Speech 103	Engineering Design and Communications Public Speaking Analysis and Performance of Literature
Basic Engineering - 5 courses in at least 4 areas	
Thermodynamics Fluids and Solids Probability, Statistics, and Quality Control Systems Engineering & Analysis (Numerical Methods) or Materials Science Basic Eng	CHEM 342-1** MECH_ENG 241- Fluid Mechanics I CIV_ENV 306 Uncertainty Analysis (recommended) CIV_ENV 304 (recommended) or IEMS 326 (EECS 328 or ES_APPM 346) or see catalog for Materials Sci
Social Sciences -- Humanities - 7 courses (see catalog for requirements)	
Unrestricted Electives - 5 courses	
Environmental Engineering Core Program - Required Core -- 12 courses	
ENVR_SCI 201	Earth: A Habitable Planet
ENVR_SCI 202	Health of the Biosphere
ENVR_SCI 203	Energy and the Environment: The Automobile
CHEM 210-1**	Organic Chemistry I
CIV_ENV 260	Fundamentals of Environmental Engineering
CIV_ENV 340	Fluid Mechanics II
CIV_ENV 361-1	Environmental Microbiology
CIV_ENV 363	Environmental Applications I: Air and Land
CIV_ENV 364	Environmental Applications II: Water
CIV_ENV 365	Environmental Laboratory
CIV_ENV 367	Aquatic Chemistry
CIV_ENV 382	CAPSTONE Design (Senior standing)
Technical Electives – 4 Total credits; 2 from TE Required List and 2 must be Engineering courses*	
TE Required List -- CHEM 210-2**	Organic Chemistry II
BIOL_SCI 210-1,2 **	Biochemistry
CHEM_ENG (CBE) 275**	Molecular and Cell Biology for Engineers
EARTH 314**	Organic Geochemistry
CIV_ENV 303**	Environmental Law and Policy
CIV_ENV 355	Engineering Aspects of Groundwater Flow
CIV_ENV 360	Environmental Impact Evaluation
CIV_ENV 361-2	Public and Environmental Health
CIV_ENV 368	Sustainability: Issues and Actions, Near and Far
CIV_ENV 398-1,2	Community-based Design
CIV_ENV 440	Environmental Transport Processes
CIV_ENV 441	Methods in Microbial Complexity
CIV_ENV 442	Processes in Environmental Biotechnology
CIV_ENV 444	Physical/Chemical Processes in Environmental Control
**Any Engineering or WCAS (math or science) course 200-level. **Not classified as Engineering.*	*400-level requires instructor permission and permission number. Other courses may be accepted by petition.*

BSEE Program in Environmental Engineering — *EXAMPLE* — *4-Year Program*

	FALL		*WINTER*		*SPRING*	
Freshman	MATH 220-0	Calculus I	MATH 224-0	Calculus II	MATH 230-0	Calculus III
	CHEM 101/171*	General Chemistry	CHEM 102/172	General Inorganic Chemistry	CHEM 103 (or ENVR_SCI 201* if CHEM 171 & CHEM 172 are taken)	
	GEN_ENG 205-1	Engineering Analysis 1	GEN_ENG 205-2	Engineering Analysis 2	GEN_ENG 205-3	Engineering Analysis 3
	H/UE or Speech		IDEA 106-1 & ENGL 106-1#	Engineering Design and Communications 1	IDEA 106-2 & ENGL 106-2 #	Engineering Design and Communications 2
					(ENVR_SCI 201*)	Earth: A Habitable Planet *(if schedule permits)*
Sophomore	MATH 234	Mult. Integra. & Vector Calc.	PHYSICS 135-2	General Physics	MECH_ENG 241	Fluid Mechanics
	GEN_ENG 205-4	Engineering Analysis 4	ENVR_SCI 202	Health of the Biosphere	ENVR_SCI 201	Earth: A Habitable Planet
	CHEM 210-1	Organic Chemistry	Basic Engineering I	or Elective	H/UE	(Speech?)
	ENVR_SCI 203	Energy and the Environment: The Automobile	H/UE		CIV_ENV 260	Fund of Env. Engrg
Junior	Basic Engrg II	(Applied Statistics) H/UE	CIV_ENV 361-1	Environmental Microbiology	Basic Engrg III	or Elective or H/UE
	CHEM 342-1	Thermodynamics	Basic Engineering I	or Elective	Technical Elective	
	CIV_ENV 363	Environmental Applications I: Air & Land	CIV_ENV 364	Environmental Applications II: Water	CIV_ENV 340	Fluid Mechanics II
	H/UE		H/UE		H/UE	
Senior	CIV_ENV 367	Aquatic Chemistry	CIV_ENV 365	Environmental Laboratory	CIV_ENG 382	CAPSTONE Design
	Technical Elective		Speech		Technical Elective	
	H/UE		H/UE		H/UE	
	H/UE		H/UE		H/UE	

*Completion of CHEM 171 is equivalent to completion of CHEM 101 and CHEM 102. Basic Engineering Elective I EECS 328 or ES_APPM 346 or one course from MAT_SCI Basic Engineering List. Basic Engineering Elective II One course from Probability, Statistics and Quality Control List (CIV_ENV 306 recommended, when offered). Basic Engineering Elective III CIV_ENV 304 Civil and Environmental Engrg Systems Analysis or IE 326 Economics and Finance for Engineers. H/UE; either Humanities/Social Sciences/Communications (9 courses) or Unrestricted Elective (5 courses). Technical Elective: 2 courses from limited list and 2 courses (200-level or above) from Tech or CAS math /science. Must include at least 1.0 units of design unless ENGG 106-1,2 are taken.

IDEA 106-1,2 and ENGL 106-1,2 are each an 0.5 unit course. They are taught concurrently and jointly by a faculty member from each department. Students must complete both quarters of both courses to receive credit for them.

P/N Policy in Environmental Engineering--A maximum of two (2) courses which can be chosen from any of the sixteen (16) in the departmental curriculum can be taken P/N. Go to http://www.mccormick.northwestern.edu/undergraduate/pass_fail.php for full McCormick policy.

An Option to Combine Academics WITH Real-World Experience: The Northwestern University CO-OP Program

At Northwestern University, The Walter P. Murphy Cooperative Engineering Education Program (CO-OP) is a 5-year educational program which gives undergraduate students in engineering an opportunity to alternate periods of academic study with periods of full-time paid work—a real-world experience related to their academic degree and their professional goals. A CO-OP student completes 12 academic quarters in addition to industry experience—the time grid below

The CO-OP program is accredited by ABET, and some or all of your CO-OP experience may count toward the experience required to become a licensed professional engineer, depending upon the state in which you apply after graduation.

You will receive an engineering degree from one of the best universities in the country PLUS one and one half years of engineering experience in industry. Because of its national standing, McCormick School of Engineering and Applied Science attracts Fortune 500 companies, as well as the best and fastest growing mid-size and small companies in the country.

The Employer Evaluations, which are completed each quarter that you work, serve as documentation of how you performed in the work place and can complement your academic transcript for future employers and graduate schools. The Program provides a campus coordinator to work with you in all aspects of your participation in the CO-OP Program.

You will be registered in a non-credit course so that your CO-OP experience becomes part of your academic history; you are continuously enrolled at Northwestern while you are working on a CO-OP assignment. Therefore, you can remain covered by your family's health insurance and automobile insurance at student rates. In addition, your student loans do not go into repayment. Your experience is documented for future professional licensing.

It is important to note that you do not pay tuition or fees during the quarters that you are on a CO-OP assignment and registered in the CO-OP course. The Tuition Rebate Program assures that you pay the same amount of tuition that you would have paid if you went straight through in four years.

See Example Schedule on next page.

BSEE Program with participation in the CO-OP Program — *EXAMPLE* —

YEAR	FALL	WINTER	SPRING	SUMMER
FRESH 1	**Quarter 1** Same as Example 4-year BSEE Program 1st year	**Quarter 2** Same as Example 4-year BSEE Program 1st year	**Quarter 3** Same as Example 4-year BSEE Program 1st year	VACATION
SOPH 2	**Quarter 4** Same as Example 4-year BSEE Program 2nd year	**Quarter 5** Same as Example 4-year BSEE Program 2nd year	**Quarter 6** Same as Example 4-year BSEE Program 2nd year	CO-OP
JUNIOR 3	**Quarter 7** Basic Engrg II (Applied Statistics) H/UE CHEM 342-1 Thermodynamics CIV_ENV 363 Environ Engrg Apps I: Air&Land H/UE	**Quarter 8** CIV_ENV 361-1, Environmental Microbiology Basic Engrg I CIV_ENV 364 Environ Engrg Apps II: Water H/UE	CO-OP	CO-OP
PRE-SENIOR 9	**Quarter 9** CIV_ENV 367 Aquatic Chemistry Technical Elective H/UE H/UE	CO-OP	**Quarter 10** Basic Engrg III Technical Elective CIV_ENV 340 Fluid Mechanics II H/UE	CO-OP
SENIOR 4	CO-OP	**Quarter 11** CIV_ENV 365 Environmental Laboratory Speech or Technical Elective H/UE H/UE	**Quarter 12** CIV_ENV 382 CAPSTONE Design Technical Elective H/UE H/UE	DONE !!!

Basic Engineering Elective I. ECE 328 or ES_APPM 346 or one course from MAT_SCI Basic Engineering List.
Basic Engineering Elective II One course from Probability, Statistics and Quality Control List. (CIV_ENV 306 recommended, when offered.)
Basic Engineering Elective III CIV_ENV 304 Civil and Environmental Engrg Systems Analysis or IE 326 Economics and Finance for Engineers.

H/UE; either Humanities/Social Sciences/Communications (9 courses) or Unrestricted Elective (5 courses).

Technical Elective: 4 Total credits: 2 from TE Required List and 2 must be Engineering (*any Engineering or WCAS—math or science—course 200-level or above).* Must include at least 1.0 units of design unless ENGG 106-1, 2 are taken.

BS-MS Program in Environmental Engineering

Imagine being able to earn a bachelor's and a master's degree in the next four years. If you are talented, highly motivated to do graduate-level work, and have earned the advanced-placement credit to complete your bachelor's degree requirements in less than four years, you don't have to imagine it. You can do it in the combined BS / MS program.

The combined BS / MS lets you work simultaneously on your undergraduate and graduate degrees. If you are interested in the combined BS / MS program, talk with your departmental advisor at the end of your sophomore year about eligibility. During your junior year of undergraduate study, you apply to the Graduate School, submitting an outline of the course work you intend to complete for the BS and MS. Your department advisor will help you select the courses necessary to fulfill both degree requirements. The Graduate School will then review your credentials and make its admission decision.

If you are not a U.S. citizen, you may have difficulty in moving from a bachelor's degree program to a master's degree program in this fashion. If you are interested in the combined BS / MS program, talk with your departmental advisor at the end of your sophomore year about eligibility.
http://masters.mccormick.northwestern.edu/

BS-MS Program in Environmental Engineering in detail by course and units.

Units	MATHEMATICS			ENGINEERING ANALYSIS	
1	MATH	214-1	5	ENGG	205-1
2		214-2	6		205-2
3		214-3	7		205-3
4		215	8		205-4

	BASIC SCIENCES			DESIGN & COMMUNICATION	
9	Chem	101	13	IDEA	106-1,2
10		102/171	14	English	106-1,2
11		103/172	15	Speech	102/103
12	Physics	135-2			

BASIC ENGINEERING

16	CHEM (not classified as Engrg)	342-1	Thermodynamics
17	MECH ENG	241	Fluid Mechanics I

18 Probability, Statistics & Quality Control: CIV ENV 306 Uncertainty Analysis, recommended when offered.

19 Numerical Methods: EECS 328 or ESAM 346; or Materials science: one course

20 Systems Engineering and Analysis: CIV ENV 304 (recommended) or IEMS 326

21-27 **SOCIAL SCIENCES & HUMANITIES (7 with distribution requirements)**

28-32 **UNRESTRICTED ELECTIVES (5)**

ENVIRONMENTAL ENGINEERING BS CORE (12)

33	ENVR SCI	201	Earth: A Habitable Planet
34	ENVR SCI	202	Health of the Biosphere
35	ENVR SCI	203	Energy and the Environment: The Automobile

36	CHEM (not classified as Engrg)	210-1	Organic Chemistry I
37	CIV ENV	260	Fundamental of Environmental Engineering
38	CIV ENV	340	Fluid Mechanics II
39	CIV ENV	361-1	Environmental Microbiology
40	CIV ENV	363	Environmental Engineering Applications: Air & Land
41	CIV ENV	364	Environmental Engineering Applications: Water
42	CIV ENV	365	Environmental Laboratory
43	CIV ENV	367	Aquatic Chemistry
44	CIV ENV	382	CAPSTONE Design (Senior standing)

45-48 **TECHNICAL ELECTIVES** 4 Total credits; 2 from TE Req List; 2 must be Engrg (any Engrg/WCAS math/science 200-level or above)

CHEM 210-2,3**; BIOL_SCI 210-1,2,3**; CHEM_ENG (CBE) 275**; EARTH 314**; CIV ENV 303**, 355, 360, 361-2, 368, 398-1,2, 440*, 441*, 442*, 444* (*400-level courses need instructor permission & permission number)

**not classified as Engrg

MS PORTION of BS-MS PROGRAM (9)

Required Core Courses (4)

#	CIV ENV	361-1	Environmental Microbiology
49	CIV ENV	365	Environmental Laboratory
50	CIV ENV	367	Aquatic Chemistry
51	CIV ENV	440	Environmental Transport Processes
52	CIV ENV	444	Physical/Chemical Processes in Environmental Control
# #	CIV ENV	448	Biophysicochemical Processes in Environmental systems
	CIV ENV	516-1,2,3	Seminar in Environmental Engineering and Science

(# Omit from MS portion of program if taken in the BS portion.)

(# # Omit from MS portion of program if CIV ENG 367 is taken in the BS portion.)

Specialization (3)

53-55 Student-initiated three course thematic specialization in some aspect of environmental engineering and science

Electives (2)

56-57 Two graduate courses in any of the following subjects(three if BS is not in environmental or civil engineering)

Environmental Engineering and Science

Applied Mathematics

Biochemistry, Microbiology, and Cell Biology

Chemical and Biological Engineering

Chemistry

Civil Engineering

Geological Sciences

Mechanical Engineering

Public Health

Course Descriptions

200s = Undergrads; 300s = Undergrads (meeting Prerequisites) and Grads; 400s = Grads and Undergrads (with permission of instructor and permission number from CEE's Academic Coordinator, j-soule@northwestern.edu)

ENVR_SCI 201 Earth: A Habitable Planet Presents a broad description of Earth System Sciences focused on the physical, chemical, and biological processes that have made the planet habitable. The first area of focus is to retrace the evolution of the planet from the early ages, when the laws of physics and chemistry ruled, to the apparition of life and the homeostatic conditions that resulted. The second is to describe, and show how we can quantify, the major biogeochemical cycles that are key in this homeostatic equilibrium. The third component is to assess the impact of human activities that can lead to minor or major perturbations and the policy efforts that have been implemented for their control. Prerequisites: MATH 224; CHEM 103 or CHEM 172.

ENVR_SCI 202 The Health of the Biosphere
Three main foci in this course: **1. Understanding mathematics of population growth** (economics of harvested populations, history and projections of human population growth, impacts of growth and increased resource use, etc); **2. Distilling important concepts from ecology and evolution** (ecological interactions, trophic structure/energy flow, overhunting, diversity-stability relationship, etc.); **3. Applying environmental economics** (cost-benefit analysis, the values of biodiversity and ecosystem function; destruction and fragmentation of habitats, etc. Prerequisites: MATH 224 or equivalent.

ENVR_SCI 203 Energy and the Environment: The Automobile
Using the automobile as example, this course provides an integrated study of fundamental chemistry (thermodynamics, atmospheric chemistry, free radical mechanics of reaction), industrial production, energy use, and public policy from an environmental perspective. Prerequisites: MATH 224; CHEM 103 or CHEM 172.

BIOL_SCI 210-1 Genetics and Evolutionary Biology 1. Transmission and demic genetics; evolutionary biology. With laboratory.. Prerequisites: MATH 220.224; CHEM 103 or 172. **BIOL_SCI 210-2 Biochemistry and Molecular Biology** 2. Lectures and laboratories in molecular and biochemical biology. Prerequisite: CHEM 210-1

CHEM 210-1,2 Organic Chemistry I, II
1. Basic concepts of structure, stereochemistry, and reactivity of organic compounds. The chemistry of hydrocarbons and alcohols. With laboratory. No P/N registration. Prerequisite: CHEM 103 or 172 (C- or better). 2. The chemistry of aromatic, carbonyl, and nitrogen compounds; characterization of organic substances by chemical and spectral methods; reaction mechanisms. With laboratory. No P/N registration. Prerequisite: CHEM 210-1 (C-or better).

MECH_ENG 241-0 Fluid Mechanics I
Fundamentals of fluid mechanics. Properties and statics of fluids. Kinematics and dynamics of fluid motion - continuity, momentum, and energy equations. Dimensional analysis, flow in closed conduits. Prerequisite: GEN_ENG 205-4.

CIV_ENV 260-0 Fundamentals of Environmental Engineering
Mass and energy concepts applied to major issues facing environmental engineers: safe drinking water, surface water quality, ambient air quality, global atmosphere, managing solid and hazardous wastes. Prerequisites: CHEM 101 and MATH 224 (take concurrently).

CHEM_ENG 275 Molecular and Cell Biology for Engineers
Introduction to cell and molecular biology concepts that provide the foundation for modern biotechnology and bioengineering. Prerequisite: CHEM 103.

CIV_ENV 303-0 Environmental Law and Policy
Introduction to many important and interesting aspects of environmental law and policy. Wide range of environmental topics focused on national environmental policy as implemented through major federal environmental statutes. Prerequisite: Junior or Senior standing.

CIV_ENV 304-0 Civil and Environmental Engineering Systems Analysis
Explores problems that arise in planning and managing engineering projects/systems. Integrates methodological tools, often used in the management sciences, with applications in civil and environmental engineering—engineering economics, decision making under uncertainty (decision analysis and dynamic programming), and optimization (constrained optimization and linear programming). Prerequisite: Junior or Senior standing; MATH 224 or equivalent (calculus and probability).

CIV_ENV 306-0 Uncertainty Analysis in Civil Engineering
Probability, statistics, and decision theory. Discrete and continuous random variables, marginal and conditional distributions, moments, statistical model selection and significance tests, hypothesis testing, and elementary Bayesian decision theory. Application to problems in soil mechanics, water resources, transportation, and structures. Prerequisite MATH 230-0

EARTH 314 Organic Geochemistry
The sources and fates of organic matter in the natural environmental; global cycling oforganic carbon; applications to the study of modern and ancient environments. Prerequisites: EARTH 201, 202 and one quarter of chemistry, or consent of instructor

CIV_ENV 361-1 Environmental Microbiology
Basic principles of microbiology; etiology of infectious and noninfectious diseases; control of environmentally-based health hazards. Prerequisite: None, but basic biochemistry and biology courses are highly recommended

CIV_ENV 361-2 Public and Environmental Health
Explores current problems in public and environmental health, such as the worldwide burden of major infectious diseases; the emergence of new pathogens, environmental reservoirs of infectious organisms, transport of microorganisms in the environment, and evaluating the combined effects of land use modification, water abstraction, and global climate change on ecosystems.. Prerequisite: CIV_ENV 361-1 or equivalent background in microbiology or biology and/or chemistry/ biochemistry.

CIV_ENV 363-0 Environmental Engineering Applications I: Air & Land
Nature and control of community air pollution. Sources, physical and chemical properties, and effects of major air pollutants; analytical measurements and monitoring of air pollutants; engineering and legislative control. Prerequisite: Junior standing.

CIV_ENV 364-0 Environmental Engineering Applications II: Water
Engineering elements of water supply and water pollution abatement. Water quality standards, water and wastewater treatment processes, and the management of receiving waters to control pollution. Prerequisite: MECH_ENG 241 and CIV_ENV 340.

CIV_ENV 365-0 Environmental Laboratory
Chemical and microbiological aspects of environmental engineering and science are explored through an integrated laboratory course. Junior standing.

CIV_ENV 367-0 Aquatic Chemistry
Chemical equilibria in natural waters. Development of the theoretical basis for the investigation of chemical behavior of aquatic systems emphasizing a problem-solving approach. Prerequisite: CHEM 103, or permission of instructor.

CIV_ENV 368 Sustainability: Issues and Actions, Near and Far
The purpose of this course is to explore the issues that motivate the design and engineering of sustainable resource use and development. Case studies and examples from both developed and developing economies are discussed/compared.

CIV_ENV 382-0 CAPSTONE DESIGN
Culminating student team design experience in Civil and Environmental Engineering, with overview of function, design, and operation of modern infrastructure systems. Prerequisite: Senior standing in Civil and Environmental Engineering, or permission of instructor.

CIV_ENV 395-0 Special Topics in Civil Engineering
Undergraduate level experimental courses.

CIV_ENV 398-1,2 Community-based Design
Year-long participation in two- or three-person team projects involving research, analysis, and/or design in the solution of environmental problems affecting primarily low-income communities. Grade assigned only on completion of both units. Prerequisite: Junior or senior standing in BSCE or BSEE and permission of instructor.

CIV_ENV 399-0 Projects
Special projects under faculty direction. Credit to be arranged. Each instructor has own section—student must obtain permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (j-soule@northwestern.edu).

CIV_ENV 440-0 Environmental Transport Processes
Processes controlling transport and fate of dissolved and suspended substances in natural and engineered environmental systems. Mass balances, hydrodynamic transport, phase and mass transfers; the fate of reactive species in complex environmental systems. Prerequisites: PHYS 135-1,2 and CHEM_ENG 321, MECH_ENG 241, or equivalent. Prerequisite: Permission from instructor and Permission Number from CEE's Academic Coordinator (j-soule@northwestern.edu).

CIV_ENV 441-0 Methods in Microbial Complexity
Principles of microbial physiology and biochemistry applied to microorganisms of environmental interest. Prerequisite: CIV_ENV 367. Prerequisite: Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (j-soule@northwestern.edu).

CIV_ENV 442 Processes in Environmental Biotechnology
Theory and practice of microbiological processes used in pollution control: kinetics of suspended growth and fixed-film processes, activated sludge, biofilm processes, nitrogen and phosphorus removal, methanogenesis. Prerequisites: CIV_ENV 440, CIV_ENV 441, and CIV_ENV 467. Prerequisite: Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (j-soule@northwestern.edu).

CIV_ENV 444 Physical/Chemical Processes in Environmental Control

Theory and practice of separations and conversions in water quality and residuals management. Water quality, coagulation, adsorption, ion exchange, membranes, oxidation, sedimentation, flocculation, filtration. Prerequisite: CIV_ENV 367, CIV_ENV 440 or equivalent. Prerequisite: Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (j-soule@northwestern.edu).

CIV_ENG 447-0 Biogeochemistry

The cycling of biogenic elements (C, N, S, Fe, Mn) in surficial environments is the focus of this course. Emphasis will be placed on microbial processes and isotopic signatures. Prerequisite: Instructor permission/Permission Number from Academic Coordinator (j-soule@northwestern.edu).

CIV_ENG 448-0 Biophysicochemical Processes in Environmental Systems

Microbiological and engineering fundamentals of bioremediation, with emphasis on current and emerging technologies for major classes of environmental contaminants and contaminated sites. Prerequisite: Instructor permission/Permission Number from Academic Coordinator (j-soule@northwestern.edu).

McCormick

Northwestern Engineering

McCormick School's Mission Statement – Excellence at All Levels

The Robert R. McCormick School of Engineering and Applied Science seeks excellence at all levels from its students, faculty, and staff. Our goal is to be a recognized world leader in science and technology-driven initiatives, such as materials and nanotechnology, bioengineering and biotechnology, infrastructure and critical infrastructure and systems. We aspire to be a world leader in societal-driven initiatives that positively impact our world. We actively collaborate with industry, governmental and peer institutions to assist us in accomplishing these goals.

Department of Civil and Environmental Engineering's Undergraduate Programs

The McCormick School's Mission Statement provides the foundation for articulating the Educational Objectives and Outcomes of the Department of Civil and Environmental Engineering's (CEE) Bachelor of Science in Environmental Engineering program.

The Educational Objectives and Outcomes and how they meet ABET (Accrediting Board for Engineering and Technology) criteria "a-k" for Environmental Engineering is presented on the two following pages. Each year, the CEE Department uses a Program Enhancement Cycle to assess student learning and improve program outcomes.

Bachelor of Science in Environmental Engineering (BSEE) Program of Study's Educational Objectives

meeting
ABET's Criteria (a-k)

BSEE Educational Objectives	*ABET criteria (a-k)*
1. Excel in the engineering practice, research and management associated with the protection and conservation of ecological and human health.	(a) Ability to apply knowledge of mathematics, science, and engineering (including chemistry, physics, earth science, biological science, and fluid mechanics). (e) Ability to identify, formulate and solve engineering problems. (k) Ability to use the techniques, skills, and modern engineering tools necessary for professional engineering practice.

BSEE Educational Objectives	ABET criteria (a-k)
	(l) Understanding of concepts of professional practice and the roles and responsibilities of public institutions and private organizations pertaining to environmental engineering.*
2. Play key roles in the analysis of the behavior of complex natural and engineered environmental systems and design infrastructure in a sustainable way to meet societal needs.	(c) Ability to design a system, component, or process to meet desired needs. (d) Ability to function on multidisciplinary teams. (e) Ability to identify, formulate and solve engineering problems. (f) Understanding of professional and ethical responsibility. (h) Broad education necessary to understand the impact of engineering solutions in a global and societal context. (j) Knowledge of contemporary issues. (k) Ability to use the techniques, skills, and modern engineering tools necessary for professional engineering practice.
3. Apply their broad environmental engineering training to excel and become leaders in a diverse range of professions including engineering consulting, industry, medicine, law, government, and education.	(c) Ability to design a system, component, or process to meet desired needs. (e) Ability to identify, formulate and solve engineering problems. (f) Understanding of professional and ethical responsibility. (g) Ability to communicate effectively. (h) Broad education necessary to understand the impact of engineering solutions in a global and societal context. (i) Recognition of the need for, and an ability to engage in life-long learning. (k) Ability to use the techniques, skills, and modern engineering tools necessary for professional engineering practice.
4. Think critically, behave ethically and consider the technical and social consequences of their work, especially as it affects the health, safety and environment of both ecological and human communities.	(f) Understanding of professional and ethical responsibility. (h) Broad education necessary to understand the impact of engineering solutions in a global and societal context. (i) Recognition of the need for, and an ability to engage in life-long learning. (j) Knowledge of contemporary issues. (k) Ability to use the techniques, skills, and modern engineering tools necessary for professional engineering practice.
5. Apply their knowledge creatively and innovatively throughout their careers to meet the challenges posed by a rapidly changing world.	(a) Ability to apply knowledge of mathematics, science, and engineering (including chemistry, physics, earth science, biological science, and fluid mechanics). (b) Ability to design and conduct experiments, as well as to critically analyze and interpret data *in more than one major environmental engineering focus area*. (d) Ability to function on multidisciplinary teams. (e) Ability to identify, formulate and solve engineering problems (g) Ability to communicate effectively. (i) Recognition of the need for, and ability to engage in life-long learning.

* Criterion “l” is an additional criterion specified by the American Academy of Environmental Engineers (AAEE).