ENVIRONMENTAL ENGINEERING

Environmental engineers uphold the dual goals of minimizing our impact on the local, regional, and global environment and concurrently improving public health and our standard of living. In this role of preserving environmental and public well-being, environmental engineers face unique issues and must have a strong background in the earth sciences to understand complex environmental problems and then pose and design appropriate engineering solutions. As problem solvers for something as diverse as "the environment," environmental engineers also need to understand the most current technologies used in practice and have a desire to maintain a high level of learning in this rapidly evolving field.

Drinking water and wastewater treatment are cornerstones of the environmental engineering field, and students' education in these areas is thorough. Turning river, lake, or even sea water into drinking water requires a unique expertise because each water source offers distinctive challenges. Air pollution is a growing concern on scales ranging from the global atmosphere to the indoor environment. From a fundamental understanding of the chemistry and dynamics of air pollution, students learn how human activities degrade air quality and also how to evaluate and design control technology to reduce emissions from industry and other sources. The geology of a location greatly impacts its water resources, and comprehension of hydrogeology is important to an environmental engineer. The amount and quality of water a geologic formation can produce can influence and limit development of a region. Subsurface hydrology can be the most critical aspect in remediation of contaminated groundwater. Sustainable infrastructure, in themes of energy and environment, is yet another challenge that environmental engineers will have the opportunity to address in their careers and our faculty are engaged in the S&T sustainability minor and teach the core coursework in sustainability at S&T.

The environmental engineering work place is diverse. Consulting firms represent a large portion of the work force and many specialize in areas of drinking water and wastewater treatment. The U.S. Environmental Protection Agency, state departments of natural resources, departments of health, and the U.S. Departments of Energy and Defense all have positions that require a wide array of skills and expertise.

The courses and skills learned as an undergraduate student also provide preparation for graduate studies and advanced leadership roles. Many specialized positions require a graduate education. Within the Missouri S&T environmental engineering program, elective courses include topics such as water and wastewater; geo-environmental; air pollution and control; environmental chemistry and processes; environmental laws and regulation; and environmental microbiology and processes. Some courses are required in each of these areas to provide breadth, which allows graduates to interact with the wide range of professionals in this particularly interdisciplinary field. Project teams may include health care professionals, city planners, developers, and all types of engineers. Additionally, the ever-developing field of environmental engineering is saturated with legal issues, many of which are yet to have precedents or legal statutes established.

Many courses include laboratory exercises in the environmental engineering program laboratories in the Butler-Carlton Civil Engineering Building. In addition to teaching laboratories, the laboratory facilities include a pilot-scale unit-operations laboratory, temperature control facilities, a roof-top greenhouse, and state of the art analytical facilities. Undergraduate-level research is encouraged and promotes participation in environmental research carried out, largely in the Center for Research in Energy and Environment. In summary, the diverse curricula, interdisciplinary faculty, and superb facilities afford students an excellent opportunity for an unparalleled education and prepare them for a bright future of solving tomorrow's problems in environmental engineering.

Mission Statement

The environmental engineering program will prepare students for a career in the global, interdisciplinary field of environmental engineering and for life-long development in the profession. The program's fundamental base in biological and earth sciences and development of specific engineering application skills prepares graduates to approach unique, atypical problems with a true problem-solving approach, develop solutions to benefit society and the environment, and promote these solutions.

Environmental Engineering Program Educational Objectives

Consistent with the mission statement, graduates of the Missouri S&T environmental engineering program will demonstrate, within a few years of graduation:

1. professional development,
2. technical competency,
3. responsibility and knowledge of leadership,
4. an ability to communicate effectively,
5. an ability to work in teams, and
6. a holistic view of problems within their field.

Program Outcomes

Consistent with the program educational objectives listed above, the Missouri S&T environmental engineering program graduates will have:

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

Environmental Engineering Bachelor of Science

The environmental engineering program at Missouri S&T is characterized by its focus on the scientific basics of engineering and its innovative application; indeed, the underlying theme of this educational program is the application of the scientific basics to engineering practice through attention to problems and needs of the public. The necessary interrelations among the various topics, the engineering disciplines, and the other professions as they naturally come together in the solution of real world problems are emphasized as research, analysis, synthesis, and design are presented and discussed through classroom and laboratory instruction.

For the bachelor of science degree in environmental engineering a minimum of 129 credit hours is required. These requirements are in addition to credit received for algebra, trigonometry, and basic ROTC courses. An average of at least two grade points per credit hour must be attained. At least two grade points per credit hour must also be attained in all courses taken in environmental engineering.

Each student's program of study must contain a minimum of 21 credit hours of course work in humanities and social sciences, and must be chosen according to the following rules:

1. All students are required to take one American history course, one economics course, one humanities course, and ENGLISH 1120. The history course is to be selected from HISTORY 1200, HISTORY 1300, HISTORY 1310, or POL SCI 1200. The economics course may be either ECON 1100 or ECON 1200. The humanities course must be a class in art, English, foreign languages, music, philosophy, speech and media studies, or theater.
2. HISTORY 2510 or HISTORY 3530 is required.
3. The remaining two courses are to be chosen from humanities (art, English, foreign languages, music, philosophy, speech and media studies, or theater) or social sciences (economics, history, political science, psychology, or sociology) and may include one communications course in addition to ENGLISH 1120 .
4. Special topics and special problems and honors seminars are allowed only by petition to and approval by the student's department chair.

Freshman Year

First Semester	Credits	Second Semester	Credits
FR ENG 1100[2]	1	MECH ENG 1720	3
CHEM 1310 & CHEM 1319	5	MATH 1215	4
MATH 1214 or 1211	4	PHYSICS 1135	4
ENGLISH 1120	3	General Education Elective[1]	6
General Education Elective[1]	3		
	16		**17**

Sophomore Year

First Semester	Credits	Second Semester	Credits
CIV ENG 2200	3	CIV ENG 2210	3
MATH 2222	4	CIV ENG 2211	1
ENV ENG 2601[3]	3	MECH ENG 2350	2
CHEM 1320 or GEOLOGY 3410	3	CHEM ENG 2100	4
BIO SCI 1113	3	ENV ENG 2602	3
		ENV ENG 3603	3
	16		**16**

Junior Year

First Semester	Credits	Second Semester	Credits
ENV ENG 3615[3]	3	ENV ENG 5619	3
CIV ENG 3330[2]	3	STAT 3113	3
MATH 3304	3	CHEM ENG 2110	3
GEO ENG 1150	3	ENV ENG Technical Elective[5,6]	3
PHYSICS 2135	4	Communications Elective[7]	3
	16		**15**

Senior Year

First Semester	Credits	Second Semester	Credits
CIV ENG 4448	3	ENV ENG 4097[3]	3
ENV ENG 4010[3]	1	ENV ENG Depth Elective[5,6]	3
CIV ENG 3334	4	ENV ENG Depth Elective[5,6]	3
ENV ENG Air Pollution Elective[4,5]	3	ENV ENG Technical Elective[5,6]	3
HISTORY 2510 or 3530	3	ENV ENG 4609	1
ENV ENG Depth Elective[5,6]	3	General Education Elective[1]	3
	17		**16**

Total Credits: 129

1. All general education electives must be approved by the student's advisor. Students must comply with the general education requirements with respect to selection and depth of study. These requirements are specified in the current catalog.
2. A grade of 'C' or better required to satisfy graduation requirements
3. Existing CIV ENG course that is cross-listed as ENV ENG course.
4. Air Pollution Elective: Choose ENV ENG 5660, ENV ENG 5662 or ENV ENG 5665. One class may not be used to fulfill both the air pollution requirement and a depth elective.
5. A grade of 'C' or better may be required in ENV ENG technical and depth elective prerequisite courses. Refer to the Missouri S&T undergraduate catalog for this prerequisite information.
6. Select depth and technical electives from approved lists. A maximum total of 6 credit hours of independent study (ENV ENG 5000 or ENV ENG 4099) can be used as depth or technical electives in the B.S. environmental engineering curriculum.
7. Choose 1 of the following: CIV ENG 2003, ENGLISH 1160, ENGLISH 3560, or SP&M S 1185

Note: All environmental engineering students must take the Fundamentals of Engineering examination prior to graduation. A passing grade on this examination is not required to earn a B.S. degree, however, it is the first step toward becoming a registered professional engineer. This requirement is part of the Missouri S&T assessment process as described in assessment requirements found elsewhere in this catalog. Students must sign a release form giving the university access to their Fundamentals of Engineering Examination score.

Environmental Engineering Depth Electives

The following classes may be used to fulfill the three depth elective courses required for the B.S. in environmental engineering:

ENV ENG 5640	Environmental Law And Regulations	3
ENV ENG 5630	Remediation of Contaminated Groundwater And Soil	3
ENV ENG 5650	Public Health Engineering	3
ENV ENG 5670	Solid Waste Management	3
ENV ENG 5605	Environmental Systems Modeling	3

ENV ENG 5642	Sustainability, Population, Energy, Water, and Materials	3
ENV ENG 5665	Indoor Air Pollution	3
ENV ENG 5660	Introduction To Air Pollution	3
ENV ENG 5662	Air Pollution Control Methods	3
GEO ENG 5331	Subsurface Hydrology	3
ENV ENG 5360	Water Resources And Wastewater Engineering	3
ENV ENG 5635	Phytoremediation and Natural Treatment Systems: Science and Design	3

One class may not be used to fulfill both the air pollution requirement and depth elective.

Environmental Engineering Technical Electives

The following classes may be used to fulfill the two technical elective courses required for the B.S. in environmental engineering:

CIV ENG 5331	Hydraulics Of Open Channels	3
CIV ENG 5335	Water Infrastructure Engineering	3
CIV ENG 5446	Management Of Construction Costs	3
CIV ENG 5360	Water Resources And Wastewater Engineering	3
CIV ENG 5448	Green Engineering: Analysis of Constructed Facilities	3
CHEM ENG 3101	Fundamentals of Transport in Chemical and Biochemical Engineering	4
CIV ENG 5744	Geosynthetics in Engineering	3
CHEM ENG 5340	Principles of Environmental Monitoring	3
GEO ENG 3148	Fundamentals Of Geographic Information Systems	3
GEO ENG 3175	Geomorphology And Terrain Analysis	3
GEO ENG 5233	Risk Assessment In Environmental Studies	3
GEO ENG 5235	Environmental Geological Engineering	3
GEO ENG 5239	Groundwater Remediation	3
GEO ENG 4276	Environmental Aspects Of Mining	3
GEOLOGY 3410	Introduction To Geochemistry	3
PET ENG 4210	Drilling and Well Integrity	3
GEOLOGY 4451	Aqueous Geochemistry	3
CIV ENG 5662/ ENV ENG 5662	Air Pollution Control Methods	3
GEOLOGY 3811	Fundamentals Of Geographic Information Systems	3
GEOLOGY 4421	Radioactive Waste Management And Remediation	3
CHEM 3410		3
CHEM 5510	Introduction to Chemical Analysis	4
CHEM 4510	Instrumental Methods Of Chemical Analysis	4
CHEM ENG 3120	Chemical Engineering Thermodynamics II	3
CHEM ENG 5130	Risk Assessment and Reduction	3
CHEM 2210	Organic Chemistry I	3
BIO SCI 2263	Ecology	3
BIO SCI 5313	Pathogenic Microbiology	3
BIO SCI 4323	Molecular Genetics	3
GEO ENG 5237	Geological Aspects Of Hazardous Waste Management	3
GEO ENG 5276	Environmental Aspects of Mining	3
GEO ENG 5320	Groundwater Modeling	3
GEO ENG 5331	Subsurface Hydrology	3
GEO ENG 5332	Fundamentals of Groundwater Hydrology	3
GEO ENG 5381	Intermediate Subsurface Hydrology And Contaminant Transport Mechs	3
MIN ENG 5742	Environmental Aspects of Mining	3
BIO SCI 3313	Microbiology	3
BIO SCI 4313	Introduction to Environmental Microbiology	3
BIO SCI 4363	Freshwater Ecology	3
BIO SCI 4316	Introduction to Geomicrobiology	3
BIO SCI 4563	Global Ecology	3
BIO SCI 4329	Molecular Genetics Laboratory	2
BIO SCI 4383	Toxicology	3
CIV ENG 5330	Unsteady Flow Hydraulics	3
CIV ENG 5332	Transport Processes in Environmental Flows	3
CIV ENG 5333	Intermediate Hydraulic Engineering	3
CIV ENG 5337	River Mechanics And Sediment Transport	3
CIV ENG 5338	Hydrologic Engineering	3

Joel G Burken, Curators Distinguished Professor[1,5]
PHD University of Iowa

Mahelet Fikru, Associate Professor
PHD Southern Illinois University-Carbondale

Mark W Fitch, Emeritus
PHD University of Texas-Austin

Shelley Minteer, Professor
PHD University of Iowa

Melanie R Mormile, Professor
PHD University of Oklahoma, Norman

Daniel B Oerther, Professor[1,5]
PHD University of Illinois-Urbana

Hunter Schroer, Assistant Professor
PHD University of Iowa

BongChul Seo, Assistant Professor
PHD University of Iowa

Sanjay Tewari, Associate Teaching Professor
PHD Texas A&M University

Jianmin Wang, Professor[1]
PHD University of Delaware

ENV ENG 2001 Special Topics (IND 0.0 and LEC 0.0)
This course is designed to give the department an opportunity to test a new course. Variable title.

ENV ENG 2601 Fundamentals Of Environmental Engineering and Science (LAB 1.0 and LEC 2.0)
Course discusses fundamental chemical, physical, and biological principles in environmental engineering and science. Topics include environmental phenomena, aquatic pollution and control, solid waste management, air pollution and control, water and wastewater treatment systems, sustainability and life cycle analyses. Prerequisites: Chem 1310, Chem 1301, or Chem 1351; Math 1214, Math 1212, or Math 1208. (Co-listed with Civ Eng 2601).

ENV ENG 2602 Biological Fundamentals Of Environmental Engineering (LEC 3.0)
Introduction to the function of organisms related to environmental engineering. The course focuses on both the application of organisms to removing contaminants and the effects of contaminants on organisms. Prerequisites: Bio Sci 1113 and preceded or accompanied by Civ/Env Eng 2601. (Co-listed with Civ Eng 2602).

ENV ENG 3001 Special Topics (IND 0.0-6.0)
This course is designed to give the department an opportunity to test a new course. Variable title.

ENV ENG 3603 Chemical Fundamentals Of Environmental Engineering (LAB 1.0 and LEC 2.0)
Introduction to the key chemical and physical concepts integral to environmental systems and processes. This course provides a fundamental background in those chemical and environmental engineering principles that are common to all environmental engineering disciplines. Prerequisites: Chem 1320 or Geology 3410; Physics 1135, Math 2222.

ENV ENG 3615 Water And Wastewater Engineering (LEC 3.0)
A study of the engineering design principles dealing with the quantity, quality and treatment of water, and the quantity, characteristics, treatment and disposal of wastewater. Prerequisites: Civ Eng 2601 and at least junior standing. (Co-listed with Civ Eng 3615).

ENV ENG 4010 Senior Seminar: Engineering In A Global Society (RSD 1.0)
Discussion of contemporary issues: public safety, health, and welfare; the principles of sustainable development; lifelong learning; impact of engineering solutions in a global and societal and political context; relationships with owners, contractors, and the public; public service; the Code of Ethics; and the Missouri licensing Statutes and Board Rules. Prerequisite: Senior standing. (Co-listed with Civ Eng and Arch Eng 4010).

ENV ENG 4097 Senior Design Project (LEC 3.0)
Open-ended design projects involving one or more areas of engineering. Planning design projects, philosophy of design, and application of engineering principles to design problems. Prerequisite: Civ Eng 4448 or Arch Eng 4448.

ENV ENG 4099 Undergraduate Research (IND 0.0-6.0)
Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

ENV ENG 4609 Research in Environmental Engineering (LEC 1.0)
Students will investigate cutting edge research in the environmental engineering field including experimental studies, current environmental policy changes, and international environmental issues. Investigation to include live research seminars, reading current literature, and/or laboratory experimentation. Prerequisite: Senior standing.

ENV ENG 5000 Special Problems (IND 0.0-6.0)
Problems or readings on specific subjects or projects in the department.

ENV ENG 5001 Special Topics (LAB 0.0 and LEC 0.0)
This course is designed to give the department an opportunity to test a new course. Variable title.

ENV ENG 5070 Teaching Engineering (LEC 3.0)
Introduction to teaching objectives and techniques. Topics include: using course objectives to design a course; communication using traditional and cutting-edge media; textbook selection; assessment of student learning; grading; student learning styles; cooperative/active learning; and student discipline. Prerequisite: Graduate standing. (Co-listed with Eng Mgt 5070, Comp Eng 5070, Elec Eng 5070, Civ Eng 5070).

ENV ENG 5360 Water Resources And Wastewater Engineering (LEC 3.0)
Application of engineering principles to the planning and design of multipurpose projects involving water resources development and wastewater collection/treatment/disposal systems. Latest concepts in engineering analysis are applied to evaluation of alternative solutions. Prerequisites: Civ Eng 3333, 3335, 3615. (Co-listed with Civ Eng 5360).

ENV ENG 5605 Environmental Systems Modeling (LEC 3.0)
Introductory course in modeling environmental systems. Course will focus on contaminant fate and transport in the environment. Models will be developed that will include physical, chemical and biological reactions and processes that impact this fate. Prerequisites: Env Eng/Civ Eng 2601, Env Eng/Civ Eng 2602 and Env Eng/ Civ Eng 3603; or Graduate standing. (Co-listed with Civ Eng 5605).

ENV ENG 5619 Environmental Engineering Design (LAB 1.0 and LEC 2.0)
Functional design of water and wastewater facilities and other environmental cleanup systems. Prerequisite: Civ Eng 3615 or Env Eng 3615. (Co-listed with Civ Eng 5619).

ENV ENG 5630 Remediation of Contaminated Groundwater And Soil (LAB 1.0 and LEC 2.0)
Course covers current in-situ and ex-situ remediation technologies. Current literature and case studies are utilized to provide the focus for class discussions and projects. Prerequisites: Civ Eng 3615, Geo Eng 5237 or Graduate Standing. (Co-listed with Civ Eng 5630).

ENV ENG 5635 Phytoremediation and Natural Treatment Systems: Science and Design (LEC 3.0)
Students learn the scientific basics of chemical transport in soil and groundwater and learn fundamental plant physiology and processes. Students then learn how these processes are utilized in design of phytoremediation and natural treatment systems, including the most up to date literature and design guidance available. Prerequisite: Env Eng 3615 or Civ Eng 3615 or graduate standing. (Co-list with Civ Eng 5635).

ENV ENG 5640 Environmental Law And Regulations (LEC 3.0)
This course provides comprehensive coverage of environmental laws and regulations dealing with air, water, wastewater, and other media. The primary focus is permitting, reporting, and compliance protocols. The course topics include U.S. and international legal systems and judicial processes, liability, enforcement, Clean Air Act, Clean Water Act (NPDES) permitting), Safe Drinking Water Act, OSGA, TSCA, RCRA, and CERCLA. Case studies will be emphasized. (Co-listed with Civ Eng 5640).

ENV ENG 5642 Sustainability, Population, Energy, Water, and Materials (LEC 3.0)
This course will examine the concepts regarding the continued advancement of humankind while maintaining our ecological niche on earth. Key topics include: population growth, poverty, and impacts of development; energy consumption, sources, storage, conservation and policy; water quality and quantity; materials and building; and policy implications. Prerequisite: Senior or graduate standing. (Co-listed with Civ Eng 5642 and Arch Eng 5642).

ENV ENG 5650 Public Health Engineering (LEC 3.0)
A comprehensive course dealing with the environmental aspects of public health. Prerequisite: Civ Eng 2601 with grade of "C" or better. (Co-listed with Civ Eng 5650).

ENV ENG 5660 Introduction To Air Pollution (LEC 3.0)
Introduction to the field of air pollution dealing with sources, effects, federal legislation, transport and dispersion and principles of engineering control. Prerequisite: Civ Eng 3330 or equivalent; or graduate standing. (Co-listed with Civ Eng 5660).

ENV ENG 5662 Air Pollution Control Methods (LEC 3.0)
Study of the design principles and application of the state-ofthe-art control techniques to gaseous and particulate emissions from fossil fuel combustion, industrial and transportation sources. Prerequisite: Civ Eng 3330 or equivalent; or graduate standing. (Co-listed with Civ Eng 5662).

ENV ENG 5665 Indoor Air Pollution (LEC 3.0)
By developing a practical understanding of indoor air pollution sources, physics, chemistry and consequences, students will learn how radon, cigarette smoke, VOCs from furnishings, and so forth affect indoor air quality and apply engineering analyses to specify ventilation rates, choose furnishings and minimize occupant exposure to pollutants. Prerequisite: Civ Eng 2601 or Mech Eng 5571 or Graduate Status. (Co-listed with Civ Eng 5665 and Arch Eng 5665).

ENV ENG 5670 Solid Waste Management (LEC 3.0)
A systematic study of the sources, amounts and characteristics of solid wastes and methods used for their collection, reclamation, and ultimate disposal. Prerequisite: Civ Eng 2601 with grade of "C" or better; or graduate standing. (Co-listed with Civ Eng 5670).
