Environmental Engineering

Professors Cal (Chair of Department), Richardson
Associate Professor Huang
Adjunct Faculty Brady, Hendrickx

Degrees Offered: B.S. in Environmental Engineering; M.S. in Environmental Engineering

Department Mission Statement

The primary objective of this program is to produce well-balanced environmental engineers capable of entering the environmental engineering profession or continuing their studies at the graduate level. Graduates will be well-prepared to solve current environmental engineering problems, and they will have the ability to adapt to problems of the future.

The achievements of environmental engineers are well-known to the general public, because environmental engineers are charged with producing clean water, disposing of waste responsibly, and maintaining air quality. Projects that environmental engineers work on include: design of water and wastewater treatment facilities, landfill design, design of air pollution control devices, and environmental law and permitting.

The undergraduate program offers a balanced approach to environmental engineering education. Students take a common core of engineering science and environmental engineering courses, including courses in environmental law, water and wastewater treatment, soil mechanics, soil and hazardous waste, hydrology and air pollution control. The environmental engineering courses teach students the fundamentals of engineering design, as well as potential applications. Students are taught how to use computer software to expedite the design process, and they are also taught how to balance engineering designs with economic constraints. During their senior year, undergraduate students work with a professor on a design thesis.

Program Educational Objectives

1. To develop graduates that function successfully in areas of environmental engineering, such as air pollution, water and wastewater treatment, and solid and hazardous waste engineering.
2. To prepare graduates for advanced education in environmental engineering and related fields, and for professional licensure.

Undergraduate Program

Bachelor of Science in Environmental Engineering

Minimum Hours Required—135
In addition to the General Education Core Curriculum (page 87), the following courses are required:

- MATH 231 (4), 283 (3), 335 (3)
- CHEM 311 (3)
- BIOL 111 (3), 111L (1), 343 (3)
- ERTH 440 (4)
- ES 110 (2), 111 (3), 201 (3), 216 (3), 302 (3), 316 (3), 347 (3), 350 (3)
- ENVE 101 (1), 201 (3), 301 (3), 302 (2), 303 (3), 304 (3), 406 (3), 411 (4), 413 (4), 480 (3) or 490 (3)
- ME 420 (3)
- Technical Electives (3): Approved technical electives include ENVE 421, 491; CE 201, 301, 302, 401, 413, 420, 422, 423; ERTH 441, 442, 443; ChE 351, 352, 443; CHEM 333, 422; EE 211; ES 305, 332; MATE 430, 460, 470; ME 220, 409, 410, 422, 427; MENG 304, 305, 421; or other

electives approved by the department chair.

Students pursuing a B.S. in Environmental Engineering must take all engineering courses for a letter grade. Environmental engineering majors must maintain a minimum GPA of 2.0 in required courses in order to graduate.

All engineering majors are required to take the Fundamentals in Engineering (FE) exam as a requirement for graduation.

Sample Curriculum for the Bachelor of Science Degree in Environmental Engineering

Semester 1

1 ENVE 101 (environmental engineering seminar)
3 ENGL 111 (college English)
4 BIOL 111 & 111L (general)
4 CHEM 121 & 121L (general)
4 MATH 131 (calculus)
2 ES 110 (intro to engineering)
18 Total credits

Semester 2

3 ENGL 112 (college English)
3 ES 111 (computer programming for engineers)
4 MATH 132 (calculus)
4 CHEM 122 & 122L (general)
5 PHYS 121 & 121L (general)
19 Total credit hours

Semester 3

4 MATH 231 (calculus)
5 PHYS 122 & 122L (general)
3 CHEM 311 (quantitative analysis)
3 ENVE 201 (intro to environmental engineering)
3 ES 201 (statics)
18 Total credits

Semester 4

3 ENVE 301 (applied principles)
3 MATH 335 (ordinary differential equations)
3 ES 216 (fluid mechanics)
3 BIOL 343 (microbiology)
3 Social Science
15 Total credits

Semester 5

3 ENVE 303 (water treatment process design)
3 ES 302 (materials)
3 ES 350 (heat and mass transfer)
3 MATH 283 (statistics)
3 ME 420 (soil mechanics)

15 Total credits

Semester 6

2 ENVE 302 (environmental law)
3 ENVE 304 (wastewater treatment process design)
3 ES 316 (engineering economics)
3 ES 347 (engineering thermodynamics)
3 ENGL 341 (technical writing)
3 Humanities
17 Total credits

Semester 7

4 ENVE 411 (solid and hazardous waste)
4 ENVE 413 (air pollution engineering)
4 ERTH 440 (hydrologic theory and field methods)
6 Social Science
18 Total credits

Semester 8

3 ENVE 406 (unit operations)
3 ENVE 480 or 490 (senior design or senior thesis)
3 Approved Technical Elective
3 Humanities
3 Humanities/Social Science
15 Total credits

Minor in Environmental Engineering

Minimum credit hours required – 18
The following courses are required:
• ENVE 201 (3), ENVE 301 (3)
• 12 additional hours of approved courses, including any ENVE courses, ME 420, or ERTH 440

Graduate Programs

Master of Science in Environmental Engineering

The Environmental Engineering graduate program at New Mexico Tech provides a unique educational and research experience in the engineering and science of the natural environment and environmental protection. The plan of study and research is suited to each individual, drawing upon the strengths of the student, taking advantage of program capabilities, and complementing research activities within and outside New Mexico. A thesis or independent study project is required to complete the degree. General requirements common to all Master of Science degree curricula also apply.

Admission to the Master of Science in Environmental Engineering program requires competence in mathematics, chemistry, biology, physics, and engineering science comparable to the Bachelor of Science in Environmental Engineering. The department chair, or an advisory committee, will evaluate the scholastic record of every entering student to determine whether any deficiencies exist in their educational background. For example, students entering the

program without an engineering degree may be required to take additional course work in such areas as fluid mechanics, heat and mass transfer, and differential equations before being granted a M.S. in Environmental Engineering. It is up to the student and his or her graduate committee to determine the specific plan of study for the student after the first semester of graduate work. Transfer credit for courses taken at another institution will be evaluated on an individual basis.

Thesis Option

A total of 30 credit hours are required for a M.S. in Environmental Engineering, which must include a minimum of 18 credit hours of Environmental Engineering coursework, and 6 credit hours of ENVE 591 (thesis). All students must take a minimum of 12 credit hours of 500-level Environmental Engineering courses.

Independent Study Option

A student may petition the department with the approval of the Department Chair to pursue a Master of Science degree with an independent study option. Candidates for the non-thesis Master of Science option must complete a minimum of 30 credit hours, of which 3 credit hours must be independent study (ENVE 590). All students must take a minimum of 12 credit hours of 500-level Environmental Engineering courses, and an additional 6 credits of 400- or 500-level Environmental Engineering courses (18 credits total). The student's course of study must be approved by the student's advisory committee, and it must fulfill the other requirements of the M.S. in Environmental Engineering degree program with the exception of 6 credit hours of thesis (ENVE 591).

Five Year Bachelor's/Master's Degree Program

A five-year B.S. /M.S. Environmental Engineering degree can be achieved by fulfilling the separate requirements of both the undergraduate degree and graduate degree. A combined minimum of 161 credit hours is required for the dual degree with at least 12 credit hours of 500-level ENVE courses and 6 credit hours of Thesis (ENVE 591). Students in the five-year program are also required to take ENVE 581 (summer). A B.S. degree in Environmental Engineering will be granted after the five-year student has completed the 134 credit-hour undergraduate requirement. For the M.S. degree, the 6 credit hours of required graduate electives must be non-ENVE courses of 300-level and above. Students with a minimum GPA of 3.0 are eligible to apply for the admission to the graduate program after the first semester of their junior year. Once admitted to the graduate program, the five-year student will spend his/her senior year as a dual registered student and all rules for graduate student status apply. A sample curriculum for the five-year B.S. /M.S. Environmental Engineering degree is listed below.

Summer

3 ENVE 581

Semester 7

4 ENVE 411
4 ENVE 413
4 ERTH 440
3 Social Science
15 Total credit hours

*Semester 8**

3 ENVE 406
3 ENVE 490
3 ENVE 510
3 Humanities/Social Science
12 Total credit hours

B.S. degree is granted

Summer

3 ENVE 591

Semester 9

3 ENVE 501
3 ENVE 503
3 ENVE 512
3 ENVE 591
12 Total credit hours

Semester 10

3 ENVE 520
3 Elective
3 Elective
3 ENVE 591 (optional)
12 Total credit hours

Summer

3 ENVE 591 (optional)

Environmental Engineering Courses:

ENVE 101, Environmental Engineering Seminar, 1 cr, 1 cl hr

Seminars by faculty, and guest speakers from industry, consulting, and government provide a brief overview of environmental engineering topics, including air pollution, water quality, and solid and hazardous waste.

ENVE 201, Introduction to Environmental Science and Engineering, 3 cr, 3 cl hr

Prerequisites: CHEM 122 & 122L; BIOL 111 & 111L; MATH 132

The fundamentals of physics, chemistry, biology, and geology applied to problem solving in science and engineering. A study of environmental phenomena and strategies to control pollution of water, air, and land. Definition of basics for water quality engineering, water treatment, wastewater treatment, solid and hazardous waste management, radioactive waste management, and air pollution. Environmental impact statements and environmental ethics.

ENVE 301, Applied Principles of Environmental Engineering, 3 cr, 3 cl hrs

Prerequisites: ENVE 201

Application of chemical and biological principles to the study of the natural environment and engineered systems related to pollution of air, water, and soil. Topics include: atmospheric chemistry, biokinetics, carbonate cycle, corrosion, complexation (coordination chemistry), redox reactions, and precipitation. Principles will be tied to specific environmental

engineering applications.

ENVE 302, Environmental Law and Regulations, 2 cr, 2 cl hrs

Prerequisite: ENVE 201

An overview of the major federal and state environmental statutes and regulations. Statutory/regulatory scheme and its application to current environmental problems. Specific regulations pertaining to air, water, toxic substances and pesticides, and solid and hazardous wastes, as well as related regulatory programs. Historical and philosophical basis of environmental regulation.

ENVE 303, Water Treatment Process Design, 3 cr, 3 cl hrs

Prerequisites: ENVE 201; or consent of instructor

Physical-chemical processes encountered in the design, analysis, and operation of municipal and industrial water treatment systems. Concepts of mass balance and chemical reactor theory applied to water quality improvements. Specific topics include flocculation/coagulation, softening, sedimentation, filtration, stabilization, disinfection, ion exchange, carbon adsorption, and gas transfer. A team design project will be required as partial fulfillment of course requirements.

ENVE 304, Wastewater Treatment Process Design, 3 cr, 3 cl hrs

Prerequisites: BIOL 343; ES 216, 350; or consent of instructor

Physical-chemical-biological processes encountered in the design, analysis, and operation of municipal and industrial wastewater treatment systems. Microbial kinetics of carbon and nutrient removal. Aerobic and anaerobic biological processes occurring in suspended growth and fixed-film reactors. Processing, management, and disposal of biosolid residuals. Specific topics include collection, pretreatment, sedimentation, trickling filters, activated sludge aerobic and anaerobic digestion. A team design project will be required as partial fulfillment of course requirements.

ENVE 406, Environmental Engineering Unit Operations, 3 cr, 2 cl, 3 lab hrs

Corerequisites: ENVE 303 or 304 or consent of instructor

Laboratory and field studies of unit operations and processes in environmental engineering. A student-designed feature will be integrated into all of the studies. Potential topics include reactor mixing and hydraulics, coagulation, flocculation, sedimentation, filtration, carbon adsorption, chemical oxidation, air stripping, etc. Emphasis on planning of studies, preparation of work plans, data collection and analysis, report writing, and technical presentation.

ENVE 411, Solid and Hazardous Waste Engineering, 4 cr, 4 cl hrs

Prerequisites: ES 350 or consent of instructor

A study of solid waste management functions: generation, transport, storage, treatment and recovery, and disposal. Emphasis on design of treatment and recovery unit operations and processes for both municipal and industrial wastes. Site selection criteria and engineering considerations for land disposal alternatives. Special consideration of hazardous waste management: treatment, storage, disposal. Uncontrolled hazardous waste sites: risk assessment and remediation design. Projects on waste management will be developed by teams as partial fulfillment of course requirements.

ENVE 413, Fundamentals of Air Pollution Engineering, 4 cr, 3 cl, 3 lab hrs

Prerequisites: ES 216 and 350; or consent of instructor

Sources, behavior, and fate of gaseous and particulate air pollutants. Principles of air quality related to visibility, atmospheric chemistry and global climate issues. Principles of meteorology and atmospheric diffusion in relation to modeling pollutant transport and dispersion. Design of air pollution control equipment for removal of gases and particles. In the laboratory section, students learn methods for incorporating emissions estimates and atmospheric dispersion modeling into an air permit application.

ENVE 421, Green Engineering, 3 cr, 3 cl hrs

Prerequisite: junior standing

Evaluating the full range of environmental effects associated with products and services from raw materials acquisition and manufacturing to use and disposal. Industrial processes, potential waste minimization procedures, relevant regulations as well as life-cycle analysis.

ENVE 480, Environmental Engineering Senior Design, 3 cr

Prerequisite: Senior standing and consent of instructor

Design of equipment, unit processes, and systems in environmental engineering through application of scientific, technological, and economic principles. Emphasis is placed upon problem formulation and the conceptual, analytical, and decision aspects of open-ended design situations. Course integrates knowledge and skills gained in previous and concurrent courses. Students work as a team in a local, regional or national design competition. A team project report is required. Instructors may also require interim reports, an individual final report, and a final presentation.

ENVE 490, Senior Design Thesis, 3 cr

Prerequisite: Senior standing or consent of instructor

Design of equipment, unit processes, and systems in environmental engineering through application of scientific, technological, and economic principles. Emphasis is placed upon problem formulation and the conceptual, analytical, and decision aspects of open-ended design situations. Course integrates knowledge and skills gained in previous and concurrent courses.

ENVE 491, Special Topics in Environmental Engineering, 3 cr, 3 cl hrs

Prerequisite: Senior standing or consent of instructor

ENVE 501, Physicochemical and Biological Processes, 3 cr, 3 cl hrs

Fundamentals of physical, chemical, and microbial processes in natural and engineered remedial systems. Phase interactions, chemical transformations, transport phenomena, and separation processes in the natural and engineered systems. Characteristics of microorganisms, microbial ecology, biokinetics, and nutrient requirements. The role of microorganisms in treatment processes and the monitoring and enhancement of *in-situ* activity.

ENVE 503, Environmental Risk Assessment, 3 cr, 3 cl hrs

Multi-disciplinary approaches required to develop credible risk analysis within the U.S. regulatory and social framework. Philosophical contexts, regulatory framework, and economic implications. Components of risk and performance assessments, including source term, contaminant transport, exposure, and consequences. Computer models and case studies.

ENVE 510, Advanced Water Chemistry, 3 cr, 3 cl hrs

Advanced study of physical and organic chemistry as applicable to natural water bodies and water and wastewater treatment. Chemical cycles, equilibrium chemistry, chemical thermodynamics, reaction kinetics, precipitation and dissolution, oxidation and reduction, colloidal and surface chemistry, complexation phenomena, electroneutrality, mass balances, and transport and fate of chemical species. Relevance of these topics to water quality control are discussed.

ENVE 511, Water Quality Management and Control, 3 cr, 3 cl hrs

Prerequisite: MATH 335 or consent of instructor

Fundamentals of water quality, including water bodies and their natural setting, water uses and waste input, and water quality cause-effect relationships. Water quality parameters, criteria, and standards; principles of water quality systems analysis, both in the formulation and application of water quality models; engineering controls and socio-economic concepts of water quality management and control, including cost/benefit analysis and management modeling.

ENVE 512, Industrial Water and Wastewater Treatment, 3 cr, 3 cl hrs

Prerequisites: ENVE 303, 304, 501; or consent of instructor

Advanced study of treatment unit operations and processes within industry-specific water and wastewater situations. Process design, specifications, and costing of physical, chemical, or biological technology to meet a particular treatment objective. Subject matter is developed through references to current practice, critique of completed designs, design exercises, and field trips.

ENVE 520, Hazardous Waste Site Remediation, 3 cr, 3 cl hrs

Prerequisites: ENVE 411, 501; or consent of instructor

Design and specification of various physical, chemical, thermal, and biological technologies commonly used in the cleanup of hazardous waste sites. Special emphasis on innovative and emerging technologies for site remediation. Proper sampling and monitoring procedures. Emergency technology in hazardous waste management.

ENVE 521, Green Engineering, 3 cr, 3 cl hrs

Evaluating the full range of environmental effects associated with products and services from raw materials acquisition and manufacturing to use and disposal. Industrial processes, potential waste minimization procedures, relevant regulations as well as life-cycle analysis. ENVE 421 and 521 share lectures, but 521 is graded separately and additional graduate-level work is required.

ENVE 522, Geotechnical Waste Containment Design, 3 cr, 3 cl hrs

Prerequisite: ME 420 or consent of instructor

Design procedures consisting of waste disposal methods, various containment systems, and associated remediation techniques. Waste characterization and soil-waste interactions, contaminant transport in low permeability soils, geosynthetics and soil materials use in waste containment, remedial issues of solidification and stabilization and barrier design, and landfill- and surface impoundment-related design, including liners, leachate and gas collection and removal, final covers, static and seismic slope stability, and settlement analysis. Geotechnical problem definition, application of field and laboratory test data, use of computer models for analysis and design.

ENVE 530, Advanced Air Pollution Engineering, 3 cr, 3 cl hrs

Prerequisite: ENVE 413 or consent of instructor

Application of basic pollution control techniques to a variety of source categories, including industrial and mobile sources. State-of-the-art and developing technologies such as catalytic combustion, advanced oxidation, and bioremediation. Classroom presentations and a semester-long design project.

ENVE 535, Transport and Fate of Air Pollutants, 3 cr, 3 cl hrs

Prerequisites: ES 216; MATH 335; or consent of instructor

Development and application of theories and techniques to predict the movement and dilution of air pollutants after emission from a pollutant source. Basics of meteorology in relation to descriptions of atmospheric motion and stability. Examination of the different types of atmospheric dispersion models (Gaussian, Eulerian, and Lagrangian). Aerosol formation mechanisms and formation of gaseous pollutants in the troposphere.

ENVE 551, Graduate Seminar, 1 cr each semester

Seminar presentations by faculty, graduate students, and guest speakers on their interests and current research topics. Graded on S/U basis.

ENVE 571, Special Topics in Environmental Engineering, 2–4 cr, 2–4 cl hrs

Prerequisite: Consent of instructor

Offered on sufficient demand

Special topics in environmental engineering.

ENVE 581, Directed Study, credit to be arranged

Independent design project conducted by the student under the direction of the student's advisor. A written final report and oral presentation are required.

ENVE 590, Independent Study, cr to be arranged

Independent research organized and conducted by the student under the direction of the student's advisor. A written final report is required

ENVE 591, Thesis (Master's Program), credit to be arranged

Faculty Research Interests

Brady—Aquatic chemistry, global change, groundwater remediation

Cal— Air quality engineering, chemical fate and transport, transportation engineering, water resources engineering

Hendrickx—Vadose zone hydrology, water and salt balance of natural and irrigated systems, evapotranspiration, remote sensing, soil physics, electromagnetic induction

Huang—Hazardous waste management, water treatment, wastewater reuse

Richardson—Biological wastewater treatment, groundwater contamination, site remediation