Environmental Engineering

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

Department Mission Statement

The main objective of this program is to produce well-balanced environmental engineers capable of entering the environmental engineering market as professionals, prepared to deal with current problems, and also having an ability to adapt to future environmental issues. The curricular content embodies the basic sciences, mathematics, humanities and social sciences, and engineering sciences common to most engineering disciplines. In addition, it draws heavily upon advanced physical, chemical, biological and engineering science concepts. An assortment of environmental engineering courses provides a strong background in the fundamentals of physical, chemical and biological processes and unit operations specific to the discipline. This approach, coupled with a program philosophy of logical analysis, critical thinking, rational design, and ethical practice, enables the environmental engineering graduate to address varied multi-media problems and develop integrated air-water-land approaches to problem solving. The program offers the graduate the environmental breadth and technological depth needed to interface with multi-disciplinary teams solving complex environmental problems. A common thread throughout the program is that environmental engineers must exercise ecological wisdom as they engineer for society with the appreciation and understanding that humans are an integral part of nature and must live harmoniously within the ecological and resource limits of the earth.

A secondary program objective is to prepare students for advanced education. A broad environmental engineering baccalaureate program has intrinsic value as a foundation for specialization in graduate school. Ancillary to this is the concept that a Bachelor of Science degree at New Mexico Tech in Environmental Engineering should not, in itself, be the final step in the educational staircase. In other words, our objective is also to provide the graduate with a foundation for continued professional growth and development and lifelong learning.

The design experience is cultivated early on in the study of environmental engineering at New Mexico Tech. Appropriate elements of design are integrated throughout the curriculum beginning with Introduction to Engineering I (ES 110) and culminating in a major comprehensive design experience offered by Senior Design Thesis (ENVE 490). The grouping or linking of coursework in engineering topics and basic and applied sciences provide a base of knowledge consistent with achieving program objectives. This coursework has been carefully selected by faculty consensus to give the student an introductory-level exposure to the fundamentals in the following major focus areas of environmental engineering: water and wastewater, solid and hazardous waste, air quality and air pollution control. Environmental engineering coursework should, therefore, include such subjects as organic chemistry, microbiology, groundwater hydrology, fluid mechanics, heat and mass transfer, and, perhaps, process instrumentation and control. The rationale for selection of specific classes is simple. The curriculum reflects an effort by the faculty to complement the major focus areas with appropriate engineering topics and relevant specialized sciences. A proficiency in these three areas of environmental engineering, augmented by professional experience, will produce those skills necessary to conceive, plan, design and implement actions required for the protection of human health and welfare and for the preservation and enhancement of our environment.

Program Educational Objectives

The Environmental Engineering Program has established a set of educational objectives to maintain and improve the quality of its undergraduate program:

1. To produce well-balanced environmental engineers capable of entering the environmental engineering market as professionals that are prepared to manage current problems, and are able to adapt to changing technologies and regulations. Target employers include environmental regulatory agencies, industrial companies, and government research laboratories.
2. To prepare students in the general areas of logical analysis, critical thinking, rational design, and ethical engineering practice to enable environmental engineering students to address a wide variety of environmental engineering problems.
3. To prepare students for advanced education in fields such as environmental engineering, environmental health, chemical engineering, and hydrology, and to prepare students for professional licensure.

Undergraduate Program

Bachelor of Science in Environmental Engineering

Minimum Hours Required—134
In addition to the General Degree Requirements (page 54), 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), 316 (3), 302 (3), 347 (3), 350 (3)
- ENVE 101 (1), 201 (3), 301 (3), 302 (2), 303 (3), 304 (3), 406 (3), 407 and 407L (2), 411 (4), 413 (4), 490 (3)
- Technical Electives (3): Approved technical electives include ENVE 421, 491; CE 201, 301, 302, 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, 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)
18	Total credit hours

Semester 2

3	ENGL 112 (college English)
3	ES 111 (intro)
4	MATH 132 (calculus)
4	CHEM 122 & 122L (general)
3	Social Science
17	Total credit hours

Semester 3

4 MATH 231 (calculus)
5 PHYS 121 & 121L (general)
3 CHEM 311 (quantitative analysis)
3 ENVE 201 (intro)
3 Humanities
18 Total credit hours

Semester 4

3 ENVE 301 (applied principles)
3 MATH 335 (ordinary differential equations)
5 PHYS 122 & 122L (general)
3 ES 201 (statics)
3 BIOL 343 (microbiology)
17 Total credit hours

Semester 5

3 ENVE 303 (water treatment process design)
3 ES 216 (fluid mechanics)
3 ES 302 (materials)
3 ES 347 (thermodynamics)
3 MATH 283 (statistics)
3 Social Science
18 Total credit hours

Semester 6

2 ENVE 302 (environmental law)
3 ENVE 304 (wastewater treatment process design)
2 ENVE 407 & 407L (soil mechanics)
3 ES 316 (engineering economics)
3 ES 350 (heat and mass transfer)
3 ENGL 341 (technical writing)
16 Total credit hours

Semester 7

4 ENVE 411 (solid and hazardous waste)
4 ENVE 413 (air pollution engineering)
4 ERTH 440 (hydrologic theory and field methods)
3 Social Science
15 Total credit hours

Semester 8

3 ENVE 406 (unit operations)
3 ENVE 490 (senior thesis)
3 Approved Technical Elective
3 Humanities
3 Humanities/Social Science
15 Total credit hours

Minor in Environmental Engineering

Minimum credit hours required – 18
The following courses are required:
- ENVE 201 (3), ENVE 301 (3)
- 12 additional hours of Environmental Engineering (ENVE) courses

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. Depending upon resource availability, students may choose an area of specialization or they may pursue a broad environmental engineering education. 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 accredited 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 ENVE coursework, and 6 credit hours of ENVE 591 (thesis). All students, regardless of specialization, must take ENVE 501 (3) and ENVE 503 (3). In additional to the required courses, students may specialize in one of several areas (listed below). Courses for the *broad* ENVE track will be offered at least once within a two-year period. Courses for the other areas of specialization will be offered upon sufficient demand.

Recommended Course Sequences for Areas of Specialization:

- **Broad**—ENVE 413 (4), 501 (3), 503 (3), 512 (3), 520 (3), 521 (3), 591 (6), technical electives (6)
- **Water Quality Engineering and Science**—ENVE 501 (3), 503 (3), 510 (3), 511 (3), 512 (3), 591 (6), technical electives (9)
- **Hazardous Waste Engineering**—ENVE 501 (3), 503 (3), 520 (3), 521 (3), 522 (3), 591 (6), technical electives (9)
- **Air Quality Engineering and Science**—ENVE 413 (3), 501 (3), 503 (3), 530 (3), 535 (3), 591 (6), technical electives (9)

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), and a minimum of 18 credit hours must be 400- or 500-level Environmental Engineering lecture or laboratory courses. The student's course of study must be approved by the student's advisory committee, and it must fulfill the other requirement 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 15 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) and ENVE 510 (spring semester) before the end of their senior year. 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; CHEM 311; or consent of instructor
Corequisite: ES 216
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 407, 407L, Soil Mechanics, 2 cr, 3 cl hrs, 3 lab hrs
(half semester only)
Prerequisite: ES 302
Stress-strain properties and engineering classification of soils. Compaction, consolidation, and seepage analysis and design. Meets with ME 420 and 420L first half of semester only.

ENVE 411, Solid and Hazardous Waste Engineering, 4 cr, 4 cl hrs
Prerequisites: ES 350 and 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 meteorology and atmospheric diffusion in relation to modeling pollutant transport and dispersion. Design of air pollution control equipment for removal of gases and particles from air streams. Unit operations examined include cyclones, electrostatic precipitators, fabric filters, wet scrubbers, incinerators, biofiltration, adsorbers, and absorbers. In the laboratory section, students will develop an air permit, and complete projects using dispersion modeling and air pollution engineering software.

ENVE 421, Green Engineering, 3 cr, 3 cl hrs
Prerequisite: Consent of instructor
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 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
Prerequisites: CHEM 333; BIOL 341 or 343; or consent of instructor
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
Prerequisite: Consent of instructor
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
Prerequisite: Consent of instructor
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
Prerequisite: Consent of instructor
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: ENVE 407 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, Civil, Environmental, Chemical 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