

Graduate Tracks

ENVIRONMENTAL ENGINEERING and WATER RESOURCES

The Environmental Engineering and Water Resources specialization within the Civil Engineering Graduate Program prepares Master's and PhD students to develop solutions to complex environmental problems, such as: characterizing and remediating degraded natural environments, preventing pollution, developing and designing advanced treatment strategies for water and waste streams, improving the sustainability and resilience of natural, municipal and industrial systems, modeling landscape behavior for water resource management and sustainability, modeling the flow and availability of water resources, characterization and control of the indoor environment, expanding environmentally benign energy production, and atmospheric air quality impacts.

The graduate program prepares students for careers in industry, government, and academia, in areas of professional practice, research, and teaching. The university, college, and department have designated the environment as a key focus area. Correspondingly, there is a wide variety of institutional and academic resources available to support the environmental program. Department faculty participate in campus-wide initiatives such as the Sustainability Institute at Ohio State, the Translational Data Analytics Institute, the Global Water Institute, and the Center for Energy Research, Training, and Innovation (CERTAIN). The department also is home to the co-Directors of the Ohio Water Resources Center, the federally-authorized and state-designated Water Resources Research Institute for Ohio.

Research

The wide variety of research activities of the faculty and staff, and the high faculty-to-student ratio of the program provides unique and interesting opportunities for research by graduate students. Current research areas in environmental engineering include: optimization of advanced oxidation processes; engineered and natural photochemical transformation of pollutants and microorganisms in both water and air; use of carbon dioxide for geothermal energy production and storage; fate and transport of manufactured nanomaterials; drinking water membrane treatment; sediment remediation; mitigation of acid mine drainage; coal combustion byproduct reuse; field and laboratory experiments in plant-water-nutrient interactions; land surface modeling for watershed and regional climate models; water resources optimization; paleo-climate reconstruction; hydrologic extreme risks; food-energy-water interactions; risks of emerging energy technologies; contaminant transport in air, groundwater, and surface water; combustion emissions; atmospheric chemistry; characterization of the indoor exposome; chemical-microbial interactions in the built environment; development of energy-efficient solutions for thermal and environmental control in buildings; stormwater management; effects of climate change on civil infrastructure; green infrastructure optimization and modeling; and research on unit processes, as well as environmental studies on applied chemistry and biology; large-scale environmental monitoring, natural disaster damage assessment, and geometric and spectral characterization of plants using sensory data (including multispectral\hyperspectral images and LiDAR) from remote sensing platforms.

Facilities

The department currently maintains wet-labs and instrumentation labs with five large fume hoods, two walk-in constant temperature rooms, and experimental apparatus for conducting state-of-the-art research in environmental engineering. Analytical equipment available for researchers include: inductively coupled plasma atomic emission spectrometer (ICP-AES), graphite furnace atomic absorption spectrometer (GFAAS), gas chromatograph with mass spectrometer (GC-MS), gas chromatograph with electron capture detector (GC-ECD), liquid chromatography - tandem mass spectrometer (LC-MS/MS), ultra-high performance liquid chromatograph (UPLC), ion chromatograph (IC), total organic carbon/nitrogen analyzer (TOC/TN), double-beam UV/Vis spectrophotometer, fluorescence spectrometer, Fourier transform infrared spectrometer, photon-

correlation spectrometer, a low angle laser diffraction particle sizer, a scanning mobility particle sizer, a photoacoustic extinctions, and EPA-equivalent analyzers for CO, NO_x, and ozone. The department is also home to a potential aerosol mass chamber, which can simulate atmospheric chemistry in a controlled environment.

Equipment for molecular biology and microbial culturing includes: BSL-2 capability, anaerobic gassing manifolds, anaerobic glove bag, laminar flow hoods, biosafety cabinets, NanoDrop nucleic acid spectrophotometer, gel electrophoresis, UV visualization, UV stratalinker, PCR thermocycler, qPCR machine, digital PCR machine, microplate reader, fluorescence microscope, chip-based capillary electrophoresis machine, and nanopore nucleic acid sequencer. There is also access to next-generation DNA sequencing services at Ohio State external to the department.

Additionally, the department maintains a variety of equipment for conducting field sampling and evaluation, including a water level recorder, portable well pumps, Manning samplers, personal air sampling equipment, pressure transducers, and grab samplers. The department participates in field studies and shares field sites and outdoor laboratories at the Ameriflux National Core Flux Site at the University of Michigan Biological Station, and the Old Woman Creek National Estuarine Research Reserve, where several meteorological flux towers are used to study the effects of climate change and ecology on the rate of emissions and sequestration of greenhouse gasses and on hydrology and water resources.

The department also has a stereoscopic measurement workstation for precision measurement of geometric parameters of plants, as well as professional software (including commercial and in-house developed) packages that performs classification and crop mapping from remote sensing images.

Researchers have access to core university facilities, such as the Center for Electron Microscopy and Analysis (CEMAS), Nanotech West, Campus Microscopy and Imaging Facility (CMIF), Campus Chemical Instrument Center (CCIC), Genomics Shared Resource, Ohio Supercomputer Center (OSC), the Center for Automotive Research (CAR), Stone Lab (the OSU field research facility on South Bass Island, Lake Erie), and the Olentangy River Wetland Research Park in Columbus.

The department maintains specialized computational facilities to address the needs of our programs. The facilities are under the auspices of the College of Engineering Region 1, which is supported, in part, by a University computer fee. The physical facility consists of three rooms with over 135 PCs and multiple printers. Students have 24/7 keycard access. Some are available on a walk-in basis; others provide studio settings for advanced users. At least 50 software packages are available, including the Microsoft Office suite, AutoCAD, various GIS and image processing packages. The University also provides an environment that gives students access to a variety of computer resources on campus, in Ohio, and on the Internet.

Faculty

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Affiliated Faculty

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Academic Program

Master of Science (MS) Program. Two types of MS programs are offered: thesis and non-thesis. The thesis option requires 30 graduate credit hours, including six (6) credit hours for research and thesis; the non-thesis option requires 33 graduate credit hours, and research and thesis hours cannot be included. A minimum of six (6) credit hours of coursework to develop depth in environmental engineering is to be selected from the current Graduate Committee-approved Table "A" listing. A minimum of six (6) credit hours of coursework to develop breadth in environmental science and engineering is to be selected from Table "B." At least three (3) credit hours of a mathematics or statistics-based course are also required.

Doctoral Degree (PhD) Program. The PhD degree requires 80 graduate credit hours, including 30 credit hours for research and dissertation. A minimum of 12 credit hours of environmental engineering coursework (Table

"A") is required. An additional eight (8) credit hours of courses from Table "B" are also required.

Non-engineering majors interested in the Civil and Environmental Engineering Graduate Program have two options for applying. *Option One* – complete the equivalent of a BS Engineering program before beginning an MS program. The sequence of courses will be tailored on a case-by-case basis, depending on the student's academic background. Contact the Graduate Program Coordinator for more information. *Option two* – receive a degree through the *Environmental Systems Science Option*, outlined as follows: Non-engineering undergraduate majors entering the Environmental Systems Science option would follow modified curricula based on an individual's coursework background. This program is designed for entering graduate students who have quantitative BS degrees in physical, geological, chemical or biological sciences. In addition to the general requirements of the Graduate School, the department has set the following minimum course requirements: Math 1151 & 1172; Chem 1210 & 1220; Physics 1250; CSE/ENGR 1221 or 1222. Graduation in this graduate track does not guarantee the eligibility of the graduate for professional engineering registration.

Course Offerings

TABLE A	Title	Credits
CIVILEN 5001	Introduction to Geographic Information Systems	4
CIVILEN 5130	Applied Hydrology	3
CIVILEN/Math 5168	Introduction to the Finite Element Method	3
CIVILEN 5220	Open Channel Hydraulics	3
CIVILEN 5230	Transport Phenomena in Water Resources Engineering	3
CIVILEN 6210	Physics of Sustainable Buildings	3
CIVILEN XX	Building Energy Simulation	3
ENGR 5797.20	Sustainable and Resilient Infrastructure in Italy	3
ENVENG 5110	Environmental Engineering Bioprocesses	3
ENVENG 5218	Measurement & Modeling of Climate Change	3
ENVENG 5120	Bioremediation of Soil and Groundwater	3
ENVENG 5140	Air Quality Engineering	3
ENVENG 5170	Sustainability & Pollution Prevention Practices	3
ENVENG 5194	Special Topics in Environmental Engineering	3
ENVENG 5195	Engineering Design for Environmental Health	3
ENVENG 5210	Advanced Physical Chemical Treatment Processes	3
ENVENG 5410	Hazardous Waste Management and Remediation	2
ENVENG 5850	Advanced Topics in Environmental Engineering	1
ENVENG 5880	Environmental Engineering Seminar	1
ENVENG 6100	Environmental Engineering Analytical Methods	3
ENVENG 6200	Fundamentals of Environmental Engineering	3
ENVENG 6210	Environmental Engineering Unit Operations	3
ENVENG 6220	Data Analysis in Environmental Engineering	3
CIVILEN 6230	Numerical Models in Water Resources Engineering	3
ENVENG 7220	Colloidal and Interfacial Processes in Aquatic Systems	3
ENVENG XXXX	Watershed Monitoring and Assessment	3
ENVENG XXXX	Green Infrastructure and Design of Stormwater Control Measures	3
TBD	Advanced Techniques in Environmental Engineering	1+
TBD	Critical Reviews in Environmental Engineering	1+
TABLE B		

CBE 5771	Air Pollution	3
CBE 5772	Principles of Sustainable Engineering	3
CBE 5779	Design and Analysis of Experiments	3
CHEM 4200	Fundamentals of Physical Chemistry I	3
CHEM 4210	Physical Chemistry II	3
CHEM 6530	Kinetics	1.5
CHEM 6550	Atmospheric Chemistry	3
EARTHSC/MICRBIO 5160	Geomicrobiology	3
EARTHSC 5651	Hydrogeology	4
EARTHSC 5717	Critical Issues in World Freshwater Resources	4
EARTHSC 5718	Aquatic Geochemistry	3
EARTHSC 5719	Environmental Organic Geochemistry	3
EARTHSC 5751	Quantitative Reservoir Modeling	4
EARTHSC 5752	Contaminant Hydrogeology	4
EEOB 5420	Aquatic Ecosystems – Ecology of Inland Waters	1.5 - 4.0
EEOB 6210	Ecotoxicology	2 - 4
ENR 5240	Environmental Molecular Sciences	2
ENR 5262	Soil Chemical Processes and Environmental Quality	3
ENR 5273	Environmental Fate and Impact of Contaminants in Soil & Water	3
ENR 5274	Computer Simulation of Soil Hydrological & Biogeochemical Processes	2
ENR 5310/FABE 5310	Ecological Engineering and Science	3
ENR 7520	Environmental Science and Law	3
LAW 8310	Energy Law	3
MECHENG 4510	Heat Transfer	3
MECHENG 5541	Heating, Ventilating, and Air Conditioning	3
MECHENG 6510	Intermediate Heat Transfer	3
MICRBIO 4000	Basic and Practical Microbiology	4
MICRBIO 4100	General Microbiology	5
MICRBIO 5155	Environmental Microbiology	3
ENVENG/PUBAFRS 5600	Science, Engineering, and Public Policy	3
PUBHEHS 7365	Environmental and Human Health Risk Assessment	3
MATH (MS only)	Students pursuing an MS in the Environmental Engineering and Water Resources track will consult with their advisor and choose courses from Statistics (4201 and above) or Mathematics (4512 and above) in order to fulfill their mathematics requirement. ENVENG 6220 can be used to meet the MATH or Table A requirement, but not both.	3



Prospective students interested in learning more about admission and funding should visit ceg.osu.edu/degrees/prospective-graduate-students.