Graduate Tracks

ENVIRONMENTAL ENGINEERING

The Environmental Engineering graduate track within the Civil Engineering Graduate Studies 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; understanding prospects and consequences of energy production and use; natural and engineered approaches for climate change mitigation; and atmospheric air quality impacts. This graduate track is recognized as an official specialization for both the MS and PhD degree, which means it is posted in the permanent record upon graduation and appears on the final transcript.

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 Discovery Themes, the Sustainability Institute at Ohio State, the Translational Data Analytics Institute, the Infectious Disease Institute, Center of Microbiome Science and the Global Water Institute. 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.

Examples of the cutting-edge research themes addressed by this specialization include

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; extracting carbon dioxide from the atmosphere (negative emissions); interactions in food-energy-water systems; 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; contaminant transport in air, groundwater, and surface water; combustion emissions; atmospheric chemistry; characterization of the indoor exposome; chemical-microbial interactions in the built environment; microbiome science, 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; 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; sustainable decision making for environmental infrastructure systems; and technology evaluation for the just transition towards a carbon-neutral economy.

Research facilities to support this specialization include

The department currently maintains wet-labs and instrumentation labs with 5 large fume hoods, 2 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), 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 extinctiometer, 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, and microplate reader. There is also access to next-generation DNA sequencing services at Ohio State external to the department.

The department also 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 Campus Electron Optics Facility (CEOF), Nanotech West, Campus Microscopy and Imaging Facility (CMIF), Microscopic and Chemical Analysis Research Center (MARC), Campus Chemical Instrument Center (CCIC), Plant-Microbe Genomics Facility, Ohio Supercomputing 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-hour, 7-days-a-week 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.

Specialization curriculum, and relationship to the core Civil Engineering graduate degree requirements

The purpose of specializations is to meet the needs of students with common, identifiable interests within the broad arena of Civil, Environmental and Geodetic Engineering and provide formal recognition for developing a particular area of expertise. Current course requirements in Civil Engineering will be kept by all the specialization students.

Current requirements for general graduate Civil Engineering are:

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 6 credit hours for research and thesis. The non-thesis option requires 33 graduate credit hours. A minimum of 6 credit hours of coursework to develop topical depth topical in a sub-discipline within Civil and Environmental Engineering is to be selected from the current Graduate Committee-approved Table A listing. A minimum of 6 credit hours of coursework to develop breadth in science and engineering

topics related to the students' thesis or research topic in Civil, Environmental and Geodetic Engineering is to be selected from Table B. At least 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 Civil, Environmental and Geodetic engineering coursework (Table A) is required. An additional 8 credit hours of courses from Table B are also required.

The specialization will maintain these requirements and will determine a narrower selection of courses in Tables A and B, as listed below.

Please see the Civil Engineering Graduate Studies Program Handbook for more information on program requirements and policies.

Eligibility for the specialization in Environmental Engineering in Civil Engineering

Any student admitted to Civil Engineering, whose thesis research topic or academic specialization are within the research scope of Environmental Engineering and that is supervised by a core faculty member of the specialization is eligible to pursue the specialization in Environmental Engineering. Requirements for admission to the specialization course of study, therefore, are: 1) Consent of the student's advisor, and 2) Completion of the specialization coursework requirements as outlined in this document. The Specialization in Environmental Engineering 'Plan of Study' form, signed by the student, advisor, and a member of the specialization subcommittee will be required to document completion of the requirements.

Integrated learning experience

Objective 1: Students will develop a set of Analytical Skills and Engineering expertise needed to address the measurement and analysis of variations and changes in the natural and built environment.

Objective 2: Students will develop an understanding of the environment in terms of the relationship among built and natural environments, public health, water and air quality and environmental protection.

Faculty

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Affiliated Faculty

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List of Required Coursework Selection

TABLE A	Title	Offering schedule	Credits
CIVILEN 5001	Introduction to Geographic Information Systems	AU, SP	4
CIVILEN 5130	Applied Hydrology	AU	3
CIVILEN/Math 5168	Introduction to the Finite Element Method	SP(even-CEGE/odd-MATH)	3
CIVILEN 5220	Open Channel Hydraulics	SP	3
CIVILEN 5230	Transport Phenomena in Water Resources Engineering	SP(even)	3
CIVILEN 6210	Physics of Sustainable Buildings	AU	3
ENVENG 5110	Environmental Engineering Bioprocesses	AU	3
ENVENG 6218	Measurement & Modeling of Climate Change	SP	3
ENVENG 5120	Bioremediation of Soil and Groundwater	AU	3
ENVENG 5140	Air Quality Engineering	SP	3

ENVENG 5170	Sustainability & Pollution Prevention Practices	SP	3
ENVENG 5195	Engineering Design for Environmental Health	AU	3
ENVENG 5210	Advanced Physical Chemical Treatment Processes	AU	3
FABENG 5310	Ecological Engineering and Science	SP	3
ENVENG 5760	Design of Urban Stormwater Control Measures	SP	3
ENVENG 5850	Advanced Topics in Environmental Engineering	AU, SP	1
CIVILEN 5880	Civil Engineering Departmental Seminar	AU, SP	1
ENVENG 6100	Environmental Engineering Analytical Methods	SP	3
ENVENG 6200	Fundamentals of Environmental Engineering	AU, SP	3
ENVENG 6210	Environmental Engineering Unit Operations	SP	3
ENVENG 6220	Data Analysis in Environmental Engineering	AU	3
CIVILEN 6230	Numerical Models in Water Resources Engineering	SP(odd)	3
CIVILEN 6240	Water Resources Systems Analysis	AU	3
ENVENG 6400	Integrated Environmental Chemical Fate and Transport	SP	3
ENVENG 7220	Colloidal and Interfacial Processes in Aquatic Systems	AU(even)	3
TABLE B			
CBE 5771	Air Pollution	AU (not currently offered)	3
CBE 5772	Principles of Sustainable Engineering	SP	3
CBE 5779	Design and Analysis of Experiments	AU	3
CHEM 4300	Physical Chemistry I	AU,SP	3
CHEM 4310	Physical Chemistry II	SP	3
CHEM 6530	Kinetics		1.5
CHEM 6550	Atmospheric Chemistry	AU(odd)	3
EARTHSC/MICRBIO 5160	Geomicrobiology		3
EARTHSC 5651	Hydrogeology	AU	4
EARTHSC 5718	Aquatic Geochemistry	AU (odd)	3
EARTHSC 5719	Environmental Organic Geochemistry	AU(even)	3
EARTHSC 5751	Quantitative Reservoir Modeling	AU	4
EEOB 5420	Aquatic Ecosystems – Ecology of Inland Waters	AU	1.5 - 4.0
EEOB 6210	Ecotoxicology	SP (even)	2 - 4
ENVENG/PUBAFRS 5600	Science, Engineering, and Public Policy	SP	3
ENVENG/ISE/FABE/PUBAFRS 6020	Fundamentals of Data-Driven Energy Systems	AU	3
ENVENG 6610	Analytic Frameworks for Science, Engineering and Policy	SP	3
ENR 5262	Soil Chemical Processes and Environmental Quality	AU	3
ENR 5273	Environmental Fate and Impact of Contaminants in Soil & Water	SP	3
ENR 5274	Ecosystems Simulation	SP	2
ENR 7520	Environmental Science and Law	AU	3
LAW 8310	Energy Law		3

FABENG 5310	Ecological Engineering and Science	SP	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	AU,SP	4
MICRBIO 4100	General Microbiology	AU,SP	5
MICRBIO 5155	Environmental Microbiology	AU	3
MATH (MS only)	Students pursuing an MS in the Environmental Engineering 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.		

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