

EWRE Preliminary Examination Procedures

Written by Christian Lastoskie, EWRE Program Director, with input from the EWRE faculty. Effective May 2018. Last modification on April 4, 2022.

Exam Procedures and Timetable

The EWRE preliminary exam will consist of two subject tests selected by the pre-candidate from seven topical areas: (1) environmental chemistry; (2) environmental microbiology and biotechnology; (3) air quality; (4) sustainable energy systems; (5) ecohydrology and environmental fluid mechanics; (6) water quality process engineering; and (7) environmental finance. The subject tests consist of open-ended exam questions prepared by the EWRE faculty. A list of study topics, also prepared by the EWRE faculty, is made available for each subject area to guide student review prior to the exam. The list of prospective topics for the open-ended exam questions is drawn from graduate courses relevant to each subject test.

A preliminary exam committee of three faculty members, including the pre-candidate's Ph.D. advisor, will be organized for each pre-candidate. The exam will consist of a one-hour written exam, followed by a two-hour oral exam in which the pre-candidate explains the written answers to the test questions, followed by a free-ranging discussion of the answers and related questions as prompted by the exam committee. The pre-candidate may select the order in which the subject tests are presented during the oral exam.

The pre-candidate's advisor may participate by asking questions, contributing written notes to the committee on the pre-candidate's exam performance, and partaking in the committee's deliberations on the exam outcome. If an examinee has two co-advisors, one of the co-advisors, by mutual agreement, will serve as the participating advisor on the pre-candidate's exam committee. The other co-advisor has the option of sitting on the exam committee as an observer (and a fourth committee member), but is not otherwise permitted to participate in the exam as a questioner, nor to provide written notes nor contribute to the deliberations on the exam outcome.

The examinee will be evaluated for command of subject matter, accuracy of responses, and presentation abilities. At the conclusion of the oral exam, the examinee will be excused and the committee will deliberate and return an outcome for the preliminary exam, by a majority vote with all committee members present, of (1) pass, (2) fail with the opportunity to retake the exam, or (3) fail with no opportunity to retake.

For a retake of the preliminary exam, the student may either retake the same subjects, or elect to take other subject areas. If the student passed one of the two exam subjects on the first testing, the student may be retested on only one subject instead of two, but with the same number of examiners (three).

The mechanics of the preliminary exam are detailed in the following timetable.

Action (deadline)	May prelim exam	January prelim exam
Pre-candidate's Ph.D. advisor notifies EWRE Program Advisor that pre-candidate wishes to take prelim exam on two designated subject areas	February 28	October 31
EWRE Program Advisor and EWRE Program Director propose prelim exam committee composition for each pre-candidate, and the EWRE group approves the committee assignments	April 7	December 7
Prelim exam committee members draft questions for the respective subject tests and present them to the EWRE group for approval	April 14	December 14
Prelim exam dates are scheduled and confirmed with pre-candidates and exam committee members	April 21	December 21
Exams are taken and committee decisions are rendered	Last two weeks of May	First two weeks of January

Exam Subject Tests

The pre-candidate will select two subject tests for the preliminary exam from among the following seven topical areas. The examiners will develop test questions that reflect the following subject matter areas and core competencies. When composing the exam questions, the faculty examiners will take into account the specific coursework that the examinee has completed in relation to each subject test at the time the exam is taken.

Subject Test	Cohort of Likely Faculty Examiners
Environmental Chemistry	Ellis, Szczuka, Semrau, Wigginton
Environmental Biotechnology and Microbiology	Daigger, Love, Raskin, Semrau
Air Quality	Batterman, Clack, Lastoskie
Sustainable Energy Systems	Adriaens, Clack, Keoleian, Lastoskie, Miller, Skerlos, Xu
Ecohydrology and Environmental Fluid Mechanics	Bricker, Cotel, Gronewald, Ivanov, Kerkez, MacVean
Water Quality Process Engineering	Daigger, Love, Raskin, Wigginton
Environmental Finance	Adriaens

The recommended list of topics for examinees to review in preparation for each subject test is presented below.

Environmental Chemistry (expectation for typical courses taken: CEE 581 and 580 or 597)

- understanding of reaction kinetics
- ability to apply organic chemical partitioning principles between phases (air, water, organic solvents, natural organic matter, mineral surfaces), including an understanding of the molecular interactions that govern partitioning, to determine chemical fate
- understanding of linear free energy relationships (single parameter and multi-parameter)
- awareness of direct and indirect photolysis reactions
- familiarity with acid/base chemistry
- ability to apply complexation and speciation principles to determine the distribution of a chemical species
- awareness of mineral precipitation and dissolution strategies for the control of metals in the environment
- understanding of redox chemistry
- ability to carry out gas-water equilibrium calculations for open systems

Environmental Biotechnology and Microbiology (expectation: CEE 582 and 592)

- knowledge of microbial diversity, physiology and phylogeny
- understanding of basic biochemistry and cell composition
- understanding of microbial bioenergetics
- ability to model microbial processes, including enzyme kinetics, growth kinetics, and microbial interactions
- ability to characterize microbial communities
- understanding of molecular biology and microbial genetics
- understanding of how to interrogate/manipulate the genomes of unusual prokaryotes
- ability to use molecular biological techniques for the enumeration and characterization of natural microbial communities
- knowledge of microbial metabolisms

Air Quality (expectation: CEE 563 and CEE 564)

- knowledge of the principal sources responsible for outdoor air pollutants and their precursor species
- understanding of pollutant formation mechanisms and how they are used to reduce emissions
- ability to design processes using catalysis, two-fluid contactors, adsorption, absorption, or membranes for gas separations and air pollution control
- awareness of the physical principles governing aerosol dynamics
- ability to design particle filtration processes using filtering media, cyclonic separation, or electrostatic precipitation
- knowledge of the principal sources of indoor air pollutants and their control strategies
- knowledge of the principal sources of greenhouse gas emissions
- ability to quantify greenhouse gas radiative forcing effects on global climate
- ability to use physical property data and thermodynamic principles to calculate the energy requirements for the separation of carbon dioxide from gas mixtures

Sustainable Energy Systems (expectation: CEE 567 and CEE 564)

- general understanding of the energy source, hardware components, efficiency / capacity limits, and emissions associated with the following generation technologies: coal-steam turbines; gas combustion turbines; natural gas combined cycle power plants; co-generation for combined heat and power; nuclear fission reactors; wind turbines; concentrating solar thermal plants; photovoltaic modules; hydroelectric / pumped hydro stations; geothermal plants; tidal power; wave energy; and ocean thermal energy conversion
- ability to apply First and Second Law principles from thermodynamics to the analysis of heat engine cycles (Carnot, Rankine, Brayton) for electric power generation
- strategies for improving the thermal efficiency of coal- and gas-fired power plants (reheat, regeneration) and for reducing combustion emissions from these plants
- ability to calculate electricity generation from wind resources, taking into account rotor size, tower height, generator capacity, and site wind speed distribution
- ability to determine the amount of insolation available for solar energy utilization, based on the location and orientation of a collector array and the calendar date and time
- awareness of strategies to minimize losses in power transmission and distribution using power factor correction
- ability to carry out integrated resource planning analysis of fixed and variable costs to identify the amount and type of generation capacity needed to meet consumer demand
- ability to conduct net present value economic analysis, taking into account discounting and fuel escalation, to evaluate energy efficiency or distributed generation projects

Ecohydrology and Environmental Fluid Mechanics (CEE 591 and CEE 521 or CEE 428)

- understanding of hydrologic fluxes and mass budgets for surface and subsurface media and interfaces
- understanding of energy fluxes and budgets for surface and below-ground media and interfaces
- comprehension of steady vs. unsteady phenomena in surface and subsurface media: flows and transport; mass and momentum
- comprehension of energy and phase change phenomena
- understanding of the role of biological elements in physical dynamics and their interactions
- use of dimensional analysis to describe fundamental physical processes

Water Quality Process Engineering (CEE 460 and CEE 580 or CEE 592)

- ability to apply concepts of aquatic chemistry and fluid mechanics
- basic understanding of organic chemistry, microbiology, and biochemistry
- awareness of constituents of concern in water streams, and appropriate levels to protect public health and the environment
- awareness of water system management (centralized and decentralized) approaches to protect public health and the environment
- ability to evaluate, and use when appropriate, physical, chemical and biochemical unit processes
- ability to model energy and mass flows across process engineering systems
- ability to model water quality process dynamic drivers (chemical reactivity, biological metabolism, and mass transfer)
- ability to combine physical, chemical, and biochemical unit processes into treatment systems to process water of various qualities and produce product water of various qualities
- understanding of approaches used to manage treatment residuals
- familiarity with tools used to support decision-making around water quality process engineered systems

Environmental Finance (CEE 504 and CEE 588)

- ability to differentiate risk and return assumptions between different asset classes
- understanding of processes, investment mandates and financial basics of traditional (stocks and bonds) and alternative asset classes (real assets, private equity, hedge funds, and structured products).
- knowledge of how structures and financial return characteristics inform capital allocations to environmental and sustainability objectives.
- ability to assess how digital investment strategies are starting to disrupt environmental finance.
- knowledge of the value of data streams in environmental investments
- ability to dissect project finance structures and place the different components in their context
- ability to quantify the effect of data uncertainty on risk and return expectations of an investment