

EWRE Preliminary Examination Procedures

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Exam Procedures and Timetable

The EWRE preliminary exam will consist of two subject tests selected by the student from six topical areas: (1) environmental chemistry; (2) environmental microbiology and biotechnology; (3) air quality; (4) sustainable energy systems; (5) ecohydrology and environmental fluid mechanics; and (6) water quality process engineering. 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 four faculty members, including the student's Ph.D. advisor, will be organized for each student. The exam will consist of a one-hour written exam, followed by a two-hour oral exam in which the student 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 student may select the order in which the subject tests are presented during the oral exam. The examinee will be evaluated for command of subject matter, accuracy of responses, and presentation abilities. At the conclusion of the oral exam, the committee will deliberate and return an outcome for the preliminary exam of (1) pass, (2) fail with the opportunity to retake the exam, or (3) fail with no opportunity to retake.

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

Action (deadline)	May prelim exam	January prelim exam
Student's Ph.D. advisor notifies EWRE Program Advisor that student wishes to take prelim exam on two designated subject areas	March 31	November 30
EWRE Program Advisor and EWRE Program Director propose prelim exam committee composition for each student, 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 students and exam committee members	April 21	December 21
Exams are taken and committee decisions are rendered	First two weeks of May	First two weeks of January

Exam Subject Tests

The student 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 student has completed in relation to each subject test at the time the exam is taken.

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

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

Environmental Chemistry

- reaction kinetics
- organic chemical partitioning between phases (air, water, organic solvents, natural organic matter, mineral surfaces), including an understanding of the molecular interactions that govern partitioning
- linear free energy relationships (single parameter and multi-parameter)
- direct and indirect photolysis
- acid/base chemistry
- complexation and speciation
- mineral precipitation and dissolution (control of metals in the environment)
- redox chemistry
- gas-water equilibrium (open systems)

Environmental Biotechnology and Microbiology

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

Air Quality

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

Sustainable Energy Systems

- 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
- application of 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
- minimization of losses in power transmission and distribution using power factor correction
- integrated resource planning analysis of fixed and variable costs to identify the amount and type of generation capacity needed to meet consumer power demand
- 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

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

Water Quality Process Engineering

- ability to apply concepts of aquatic chemistry and fluid mechanics
- basic understanding of organic chemistry, microbiology, and biochemistry
- constituents of concern in water streams, and appropriate levels to protect public health and the environment
- 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
- approaches used to manage treatment residuals
- familiarity with tools used to support decision-making around water quality process engineered systems