EN.575 (ENVIRONMENTAL ENGINEERING AND SCIENCE)

Courses

EN.575.601. Fluid Mechanics. 3 Credits.
This course introduces the principles of continuity, momentum, and energy applied to fluid motion. Topics include fluid properties, cavitation and phase changes, hydrostatics, applications of Reynold Transport Equation to control volume analyses, laminar and turbulent flow, viscous boundary layers, form and surface resistance with applications to flow in conduits and channels, pumps, and turbines. This course requires a team project evaluating the design and operational parameters for fluid systems under safety and environmental constraints.

EN.575.615. Ecology. 3 Credits.
The course examines an introduction to the organization of individual organisms into populations, communities, and ecosystems and interactions between organisms, humans, and the environment. Topics include causation and prediction in ecology; evolution and natural selection; populations and competition; biodiversity, extinction, and conservation; the impact of forest fragmentation and deforestation on diversity, erosion and sedimentation; wetland ecology and restoration; succession, stability, and disturbance; eutrophication and the Chesapeake Bay; island biogeography; and global climate change. An independent project will be required regarding a field site visited by the student; the student will examine an ecological, conservation, or restoration event or issue about that site.

EN.575.619. Principles of Toxicology, Risk Assessment & Management. 3 Credits.
Risk assessment and risk management have become central tools in continued efforts to improve public safety and the environment within the limited resources available. This course introduces the basic concepts of environmental risk assessment, relative risk analysis, and risk perception, including identifying and quantifying human health impacts and evaluating ecological risk. The course describes legislative and regulatory initiatives that are attempting to base decisions on risk assessment, along with the controversy that surrounds such approaches. It also addresses specific federal requirements for risk analysis by industry. The course discusses the realities of using risk assessments in risk management decisions, including the need to balance costs and benefits of risk reduction, issues of environmental equity, accounting for the uncertainties in risk estimates, effective risk communication, and acceptable risk.

EN.575.626. Hydrogeology. 3 Credits.
This course is an introduction to groundwater, geology, and to the interactions with contaminant transport between the two. It provides a basic understanding of geologic concepts and processes, focusing on understanding the formation and characteristics of water-bearing formations. The course also addresses the theory of groundwater flow, the hydrology of aquifers, well hydraulics, groundwater resource evaluation, and contaminant fate and transport in groundwater.
The relationship between the geologic concepts/processes and the groundwater resource are discussed. Examples include a discussion of the influence of the geologic environment on the availability and movement of groundwater and on the fate and transport of groundwater contaminants. Geotechnical engineering problems associated with groundwater issues are also covered.Prerequisites: Calculus I, Calculus II, Ordinary Differential Equations.

EN.575.629. Modeling Contaminant Migration through Multimedia Systems. 3 Credits.
This course addresses contamination in several physical media as chemical species that migrate through an integrated environment. Contaminants can be released into air, subsurface or surface water from which chemicals can migrate between these media. Predicting the movement as well as human health and ecological impacts of contaminants between the air, groundwater and surface water media requires consideration of transport and fate processes that occur separately within each medium as well as linkages of contaminant interactions between media. The course presents the basic principles and computational methods for simulation of contaminant transport and kinetic fate processes in air, groundwater and surface water. Course assessments include interactive discussion topics, assignments and a course project. Screening level models will be used to evaluate transport and fate of contaminants in the air, groundwater and surface water media for a course project based on a hypothetical yet realistic case study of an industrial facility in the Washington DC region. Students will be responsible for data setup and coding of equations to create Excel spreadsheet models for contaminant fate and transport in the air and surface water and will be responsible for data setup for application of a public-domain Excel spreadsheet model for subsurface contaminant fate and transport in groundwater. Although there are no formal prerequisites for this course, the instructors strongly recommend that the student have a college-level understanding of calculus and fluid mechanics and have good quantitative skills with engineering calculations. Proficiency with the Microsoft Excel spreadsheet program is critical for data setup, coding of equations for model calculations and creating graphic plots of data and multi-media model results.

EN.575.643. Chemistry of Aqueous Systems. 3 Credits.
This course examines the chemical principles necessary to understand water quality and contaminant fate in natural and engineered aqueous systems. Quantitative problem-solving skills are emphasized. Specific topics include acid-base reactions, carbonate chemistry, oxidation-reduction reactions, and metal speciation. Case studies applying fundamental principles to important environmental phenomena (e.g., eutrophication of surface waters, drinking water treatment, soil/ subsurface contamination, ocean acidification, and geoengineering) are key components of this course.

EN.575.645. Environmental Microbiology. 3 Credits.
This course covers fundamental aspects of microbial physiology and microbial ecology. Specific areas of focus include energetics and yield, enzyme and growth kinetics, cell structure and physiology, metabolic and genetic regulation, microbial/ environmental interactions, and biogeochemical cycles. The goal of this course is to provide a basic understanding and appreciation of microbial processes that may be applicable to environmental biotechnology.

EN.575.704. Applied Statistical Analysis and Design of Experiments for Environmental Applications. 3 Credits.
This course introduces statistical analyses and techniques of experimental design appropriate for use in environmental applications. The methods taught in this course allow the experimenter to discriminate between real effects and experimental error in systems that are inherently noisy. Statistically designed experimental programs typically test many variables simultaneously and are very efficient tools for developing empirical mathematical models that accurately describe physical and chemical processes. They are readily applied to production plant, pilot plant, and laboratory systems. Topics covered include fundamental statistics; the statistical basis for recognizing real effects in noisy data; statistical tests and reference distributions; analysis of variance; construction, application, and analysis of factorial and fractional-factorial designs; screening designs; response surface and optimization methods; and applications to pilot plant and waste treatment operations. Particular emphasis is placed on analysis of variance, prediction intervals, and control charting for determining statistical significance as currently required by federal regulations for environmental monitoring.Prerequisite: Undergraduate statistics is strongly recommended

EN.575.708. Open Channel Hydraulics. 3 Credits.
The course covers application of the principles of fluid mechanics to flow in open channels. Topics include specific energy and momentum basics, uniform flow, flow resistance, gradually varied flow, flow transitions, channel design, channel stability and erosion protection, and hydraulic structures. The course also addresses 1D flow numerical computations in irregular and natural channels, and gradually varied flow modeling using HEC-RAS computer software.
Prerequisite(s): EN.575.601 Fluid Mechanics or an equivalent course in fluid flow or hydraulic and basic geometry and basic calculus.

EN.575.713. Field Methods in Habitat Analysis and Wetland Delineation. 3 Credits.
This course provides students with practical field experience in the collection and analysis of field data needed for wetland delineation, habitat restoration, and description of vegetation communities. Among the course topics are sampling techniques for describing plant species distributions, abundance and diversity, including the quadrat and transect-based, pointintercept, and plot-less methods; identification of common and dominant indicator plant species of wetlands and uplands; identification of hydric soils; and the use of soil, topographic and geologic maps and aerial photography in deriving a site description and site history. Emphasis is placed on wetland vegetation, delineation and restoration. While many of the field examples are centered in the Maryland and Washington, DC region, the format is designed so that the student performs field work in the state, country or region in which he or she would like to specialize.
Prerequisite(s): EN.575.615 Ecology.

EN.575.716. Principles of Estuarine Environment: The Chesapeake Bay Science and Management. 3 Credits.
The course examines the basic physical, chemical, and biological components of the Chesapeake Bay ecosystem and how they interrelate in both healthy and degraded states of an estuary. The course focuses on the tidal waters of the Chesapeake Bay and its tributaries. It also covers the relationships of the bay with the surrounding watershed, atmosphere, and ocean as well as relevance to other coastal systems. Particular emphasis is on to anthropogenic stresses such as nutrient and contaminant pollution, habitat modification, and harvest of fish and shellfish. The most current Chesapeake Bay management issues and policies being pursued at the federal, state, and local levels of government are discussed in depth, including their scientific foundation.

EN.575.717. Hydrology. 3 Credits.
This course introduces the fundamental physical principles that are necessary to understand the occurrence, distribution, and circulation of water near Earth's surface. Students will be introduced to the global hydrological cycle and the influence of climate, geology, and human activity. Students will study the processes of precipitation and evapotranspiration; surface water flow, floods, and storage in natural and artificial reservoirs; groundwater flow; and whole-cycle catchment hydrology. Although less emphasized, water-quality and water resources management issues will be discussed and case studies presented. Throughout the course, a quantitative approach is taken in which mathematical descriptions of hydrological phenomena will frequently be an objective. The course will also provide an introduction to hydrological data acquisition and analysis.
Prerequisite(s): EN.575.601 Fluid Mechanics or an equivalent course in fluid flow or hydraulics.

EN.575.720. Air Resources Management and Modeling. 3 Credits.
This course focuses on air pollution management and modeling topics with an emphasis on how air quality models can be used to help inform decision makers. In addition to introducing the fundamentals of air pollution and addressing general modeling considerations, topics covered in this course include the health and environmental effects of key air pollutants, how air quality modeling was used in major studies leading to better air quality, US requirements for air quality modeling studies, and current local, national, and international air pollution issues. Atmospheric physics and chemistry are reviewed as they relate to air pollutant transport and transformation. Specific modeling topics include box and plume models, indoor air quality and monitoring, numerical and statistical models, and climate change modeling and decision making. Specific air pollution problems addressed in the course include those at local, regional, and national scales; air pollution problems from a public health perspective; and approaches for developing air pollution control strategies for various air pollutants. A term-long case study assignment is required that leverages these course elements to address a timely and relevant real-world air pollution scenario.

EN.575.727. Environmental Monitoring and Sampling. 3 Credits.
Environmental monitoring and sampling provides the information needed for assessments of compliance with environmental criteria and regulatory permits, and status/trends to evaluate effectiveness of regulatory controls. Students will prepare a Sampling and Analysis Plan (SAP) as a course project to support a site-specific field data collection study for environmental sampling of air, surface water, groundwater, and soils. An overview of historical/current environmental issues, including public health and environmental impacts, for air, surface water, groundwater, and soil, is presented. An overview of regulatory requirements of federal environmental statutes and assessments of effectiveness of the Clean Water Act, Clean Air Act, Safe Drinking Water Act, CERCLA, and RCRA is presented. The course describes pollutant sources and physical, chemical, biological processes that govern transport and fate of contaminants in air, surface water, groundwater, and soils. The course examines the principles, methods, and strategies for monitoring and sampling of air, surface water, groundwater, and soil. Sampling methods are presented for discrete sampling, automated data acquisition, and remote sensing for air, surface water, groundwater, and soils. SAP requirements for the course project will be presented, including key elements of Quality Assurance Project Plans and Field Sampling Plans. The course presents selected concepts of environmental statistics; an overview of data sources available from EPA, USGS and other agencies for air, surface water, groundwater, and soils; and interpretation of environmental data sets with GIS/mapping, data analysis, and statistical methods to support decision-making, site characterization, and evaluation of status/trends. Students will research online opportunities for "virtual" field trips to observe field sampling methods for air, surface water, groundwater, and soils media.

EN.575.728. Sediment Transport and River Mechanics. 3 Credits.
This course examines the processes of sediment entrainment, transport, and deposition and the interaction of flow and transport in shaping river channels. Topics reviewed include boundary layer flow; physical properties of sediment; incipient, bed-load, and suspended-load motion; bed forms; flow duration; sediment loads; hydraulic roughness; scour and deposition of bed material; bank erosion; sediment budgets; channel classification, and size, shape, planform, and migration of river channels. In addition, the course develops techniques of laboratory, theoretical, and sediment modeling and applies them to problems of sediment transport, channel morphology, and channel change. Prerequisite(s): A course in fluid mechanics or an equivalent course in fluid flow or hydraulics. A course in statistics is strongly encouraged

EN.575.730. Geomorphic and Ecologic Foundations of Stream Restoration. 3 Credits.
This course presents principles from hydrology, sedimentation engineering, geomorphology, and ecology relevant to the design and evaluation of stream restoration projects. A watershed context is emphasized in developing the background needed to assess different design approaches. After developing a common foundation in stream dynamics, the course considers trade-offs among restoration objectives, the merits of analog and predictive approaches, the role of uncertainty in restoration design, and metrics for assessing ecological recovery. The course includes online discussions, design exercises, and review papers and finishes with an assessment of a stream in students' geographic regions.

EN.575.743. Atmospheric Chemistry. 3 Credits.
Earth's atmosphere is a vital and fragile component of our environment. This course covers the chemical composition of the atmosphere and the principles of chemistry that control the concentrations of chemical species. Following an introduction to the atmosphere, including its structure and composition, the course investigates basic concepts relating to atmospheric chemical kinetics and photochemistry. This foundation of chemistry and physics is applied to the study of the gas-phase chemistry of the troposphere and the stratosphere including focused study of criteria pollutants such as carbon monoxide (CO), tropospheric and stratospheric ozone (O3), chlorinated fluorocarbons (CFCs), sulfur and nitrogen oxides (NOx and SOx) and particulate matter (PM). Many trace species and their impacts on atmospheric chemistry are investigated. Condensedphase chemistry topics include aqueous-phase chemistry, the chemistry of clouds and fogs and aerosol chemistry (including particulate matter chemistry). The chemistry of climate change and the radiative forcing of atmospheric constituents is studied. The relationship between atmospheric chemistry and air quality is stressed via focusing on negative human health and environmental impacts. The course stresses application of these concepts to current and relevant atmospheric chemistry issues.

EN.575.744. Environmental Chemistry. 3 Credits.
This course focuses on the environmental behavior and fate of anthropogenic contaminants in aquatic environments. Students learn to predict contaminant properties influencing contaminant transfers between hydrophobic phases, air, water, sediments, and biota, based on a fundamental understanding of physico-chemical properties, intermolecular interactions, and basic thermodynamic principles. Mechanisms of important transformation reactions and techniques and quantitative models for predicting the environmental fate or human exposure potential of contaminants are discussed.

EN.575.763. Nanotechnology and the Environment: Applications and Implications. 3 Credits.
This course explores the positives and negatives of nanotechnology: the benefits to use in commercial and environmental applications, as well as considering nanoparticles as an emerging environmental contaminant. The course will analyze nanotechnology through an interdisciplinary outlook for a life-cycle analysis. This analysis will begin with synthesis, manufacturing, unintentional releases, and disposal. We will consider ecological consequences and public health implications of the use of nanotechnology. Students will learn the science behind nanotechnology and how nanoparticle characteristics impact transport in the environment, including human exposure assessment, and a discussion of current measurement tools. Policies regulating nanotechnology and risk assessment will be addressed.

EN.575.801. Independent Project. 3 Credits.

This course provides students with an opportunity to carry out a significant project in the field of environmental engineering, science, technology, planning, or management as a part of their graduate program. The project is individually tailored and supervised under the direction of a faculty member and may involve conducting a semester-long research project, an in-depth literature review, a non-laboratory study, or application of a recent development in the field. The student may be required to participate in conferences relevant to the area of study. To enroll in this course, the student must be a graduate candidate in the Environmental Engineering, Science, and Management Program within the latter half of the degree requirements and must obtain the approval and support of a sponsoring faculty member in the Department of Environmental Health and Engineering. The proposal description and completed required forms must be submitted prior to registration for approval by the student's advisor and the program chair. A maximum of one independent project course may be applied toward the master's degree or post-master's certificate.