EN.575 (ENVIRONMENTAL ENGINEERING)

EN.575.604. Principles of Environmental Engineering. 3 Credits.
This course addresses the wide range of environmental engineering fundamentals with quantitative analyses where applicable. Topics include mass and energy transfer and balances; environmental chemistry; mathematics of growth and decay; risk assessment and management; surface water pollutants, biological and chemical oxygen demands; eutrophication; water supply systems and drinking water standards; wastewater treatment systems and effluent standards; groundwater flow, contaminant transport, and remediation technologies; hazardous waste and pollution prevention; remedial and corrective actions at contaminated sites; air pollution sources, control technologies, and atmospheric stability; ambient air quality standards and indoor air quality; global temperature, greenhouse effect and warming potential; global energy balance, carbon emission, and stratospheric ozone depletion; solid waste management, landfill disposal, combustion, composting, and recycling; medical waste; and environmental law, ethics, and justice. Field trips are integrated into the classes. Course Note(s): This course is required of all degree students studying environmental engineering, science, and management who do not possess an undergraduate degree in environmental engineering.

EN.575.605. Principles of Water and Wastewater Treatment. 3 Credits.
Water quality objectives and the chemical, physical, and biological processes necessary for designing and managing modern drinking water and wastewater treatment plants are described in the course. The principles of coagulation, flocculation, sedimentation, filtration, biological treatment, solids handling, disinfection, and advanced treatment processes are presented. The course serves as a basis for the more advanced courses: EN.575.745 Physical and Chemical Processes for Water and Wastewater Treatment, EN.575.706 Biological Processes for Water and Wastewater Treatment, and EN.575.746 Water and Wastewater Treatment Plant Design.
Prerequisite(s): EN.575.601 Fluid Mechanics or an equivalent course in fluid flow or hydraulics; two semesters of undergraduate chemistry.

EN.575.606. Water Supply and Wastewater Collection. 3 Credits.
This course covers the fundamental but practical issues of water distribution systems and wastewater/stormwater collection systems. Specific topics of interest in water supply include water supply master planning; design of water storage facilities, water mains, and pumping stations; distribution-system water quality; and service connection issues. Topics covered under wastewater/stormwater collection include hydrology and hydraulics of stormwater/wastewater conveyance systems; design of stormwater detention and retention facilities; and collection system control technologies including green infrastructure. Also covered are regulations governing sanitary sewer overflows (SSOs) and combined sewer overflows (CSOs); public health, environmental, and economic impacts of SSOs and CSOs; sewer system evaluation and rehabilitation methods; stormwater best management practices; and the benefits and challenges of water reuse. Through research papers and discussion forums, students examine case studies that illustrate diverse practical situations and stimulate creative ideas for solving real-life design problems.
Prerequisite(s): EN.575.601 Fluid Mechanics or an equivalent course in fluid flow or hydraulics.

EN.575.607. Radioactive Waste Management. 3 Credits.
This course covers fundamental aspects of radioactive substances in the environment; remediation processes for these substances; and their eventual storage, processing, and disposal. It provides a basic understanding of radioactivity and its effect on humans and their environment, as well as the techniques for their remediation and disposal. Topics include radioactivity, the nucleoids, interaction of radiation with matter, shielding, dosimetry, biological effects, protection standards, sources of environmental radiation, risk evaluation, fate and transport analysis, cleanup standards, legal requirements, cleanup technologies, waste disposal, and case studies.

EN.575.620. Solid Waste Engineering & Management. 3 Credits.
This course covers engineering and scientific concepts and principles applied to the management of municipal solid waste (MSW) to protect human health and the environment and the conservation of limited resources through resource recovery and recycling of waste material. Topics include regulatory aspects and hierarchy of integrated solid waste management; characterization and properties of MSW; municipal wastewater sludge utilization; hazardous waste found in MSW; collection, transfer, and transport of solid waste; separation, processing, combustion, composting, and recycling of waste material; and the landfill method of solid waste disposal, which encompasses guidelines for design, construction, operation, siting, monitoring, remedial actions, and closure of landfills. Permitting and public participation processes, current issues, and innovative approaches are also addressed.

EN.575.623. Industrial Processes and Pollution Prevention. 3 Credits.
This course presents the pollution prevention and waste minimization concepts, terminologies, life cycle impacts, and management strategies. The course introduces available remediation techniques for industrial pollution control and prevention and examines specific applications to industries including biological, chemical, physical, and thermal techniques. Topics include current state of knowledge of pollution prevention approaches to encourage pollution prevention strategies, highlights of selected clean technologies and clean products, technical and economic issues, incentives and barriers to pollution prevention, and the role of different sectors in promoting pollution prevention. Pollution prevention and waste minimization techniques such as waste reduction, chemical substitution, production process modification, and reuse and recycling will be addressed with regard to selected industries.

EN.575.703. Environmental Biotechnology. 3 Credits.
This course examines current applications of biotechnology to environmental quality evaluation, monitoring, and remediation of contaminated environments. The scale of technology ranges from the molecular to macrobiotic. Relevant topics of microbiology and plant biology are presented. These provide a foundation for subsequent discussions of microbial removal and degradation of organics, phytoremediation of soil and water contaminated with toxic metals and radionuclides, wetlands as treatment processes, biofilms/biofilters for vapor-phase wastes, and composting. Emphasis is placed on modeling and design. Advantages and disadvantages of each application are compared. Case studies are presented in the areas of biosensors in environmental analysis, molecular biology applications in environmental engineering, and genetic engineering of organisms for bioremediation. Prerequisite(s): Prior coursework in environmental microbiology or biochemical engineering is recommended but not required.

EN.575.706. Biological Processes for Water & Wastewater Treatment. 3 Credits.
This course develops the fundamentals and applications of aerobic and anaerobic biological unit processes for the treatment of municipal and industrial wastewater. The principles of activated sludge, aeration and clarifier design, fixed film reactors, anaerobic treatment, solids handling and treatment, land treatment, and nutrient removal are presented. This course uses concepts from microbiology and the basic principles of stoichiometry, energetics, and microbial kinetics are used to support the design of biological unit processes.
Prerequisite(s): EN.575.605 Principles of Water and Wastewater Treatment.

EN.575.715. Subsurface Fate and Contaminant Transport. 3 Credits.
This course provides an introduction to the concepts relating to the nature and sources of environmental contaminants in the subsurface, the role of groundwater and soil water in mobilizing and spreading contamination, the processes that control distribution and fate of subsurface contamination, the accepted methods of investigating and analyzing contamination, and the analytical techniques that can be employed to model contaminant fate and transport in the subsurface. The course also considers surface water contamination caused by contamination in the groundwater. Computer laboratories of groundwater model simulations and solute transport solutions are used.

EN.575.721. Air Quality Control Technologies. 3 Credits.
This is a multidisciplinary course that involves the applications of chemistry, thermodynamics, and fluid mechanics in the selection and design of air pollution control equipment. Topics include the estimation of potential pollutants, chemical characterization of gas streams to be controlled, theory and practice of air pollution control, and design and costing of control technologies. The course emphasizes the design of systems to reduce particulate matter emissions, volatile organic compound (VOC) emissions, nitrogen oxide emissions, and sulfur dioxide emissions.
Prerequisite(s): EN.575.601 Fluid Mechanics or an equivalent course in fluid flow; an undergraduate course in thermodynamics.

EN.575.722. Sensor Applications for Environmental Monitoring and Exposure Assessment. 3 Credits.
The primary objective of this course is to present the fundamentals of sensor design in the application of environmental monitoring. The course will examine the basic sensor design and operation in specific environmental applications including ambient, built, personal, and social. Other topics to be covered include, data capture, storage, transmission, as well as analysis of the legal and policy requirements for environmental monitoring with sensors.

EN.575.741. Membrane Filtration Systems and Applications in Water and Wastewater Treatment. 3 Credits.
This course covers fundamentals of membrane filtration technology and application in municipal and industrial water and wastewater treatment. Topics include membrane classification, mechanism of separation/filtration, principle of operation, performance monitoring, maintenance, pilot scale testing, residual disposal, emerging and developing membrane separation technologies, and regulations governing treatment objectives and residual disposal in membrane filtrations systems. This course provides students with in-depth knowledge of the theory, application, and design of membrane filtration systems by engaging them in group assignments and design projects.

EN.575.742. Hazardous Waste Engineering and Management. 3 Credits.
The course addresses traditional and innovative technologies, concepts, and principles applied to the management of hazardous waste and contaminated sites to protect human health and the environment. Topics include regulatory requirements; hazardous waste generators and transporters; permitting and enforcement of hazardous waste facilities; closure and financial assurance requirements; RCRA Corrective Action and CERCLA/Superfund/Brownfields site remediation processes; groundwater flow and fate and transport of contaminants; physical, chemical, and biological treatment; land disposal restrictions; guidelines for design, construction and closure of hazardous waste landfills; environmental monitoring systems; management of medical waste and treatment options; management of underground and aboveground storage tanks; toxicology and risk assessment; and pollution prevention and waste minimization.

EN.575.745. Physical and Chemical Processes for Water and Wastewater Treatment. 3 Credits.
In this course, mass and momentum transport, aquatic chemistry, and chemical reaction engineering are applied to physical and chemical processes used for water and wastewater treatment. Students also learn the theory and practice of various unit processes including disinfection, oxidation, coagulation, sedimentation, filtration, adsorption, gas transfer, and membrane filtration. The goal is to provide a theoretical understanding of various chemical and physical unit operations, with direct application of these operations to the design and operation of water and wastewater treatment systems. Students will use the concepts learned in this class to better understand the design and operation of engineered and natural aquatic systems.
Prerequisite(s): EN.575.605 Principles of Water and Wastewater Treatment.

EN.575.746. Water and Wastewater Treatment Plant Design. 3 Credits.
This course familiarizes students with appropriate design criteria and the design process for water and wastewater treatment plants. This includes design of treatment processes, cost estimates, and a working design team under project managers. Additional course requirements include oral presentations and writing engineering reports.
Prerequisite(s): EN.575.605 Principles of Water and Wastewater Treatment and either EN.575.706 Biological Processes for Water and Wastewater Treatment or EN.575.745 Physical and Chemical Processes for Water and Wastewater Treatment.and Wastewater Treatment)

EN.575.761. Measurement and Pseudo-measurement in the Environmental Arena. 3 Credits.
In this course, students will be provided with the knowledge to critically investigate practical, theoretical, mathematical, philosophical, sociological, and legal aspects of measurement and pseudo-measurement in environmental science and related disciplines. Students will explore the theoretical and mathematical bases for quantification and trace the relationship between these bases and the expanding role of quantification and pseudo-quantification in environmental research, policy, and decision making. Three theories of measurement (traditional, representational, and operational) will be presented from historical, technical, and philosophical perspectives. Claims to quantification arising in a number of environmental contexts (such as river systems and hydrology) will be closely examined in light of these divergent measurement paradigms.

EN.575.762. Resilience of Complex Systems. 3 Credits.
This course will present a subset of the mathematical techniques often use to gain an understanding of the response of complex systems to acute events and compound threats. Examples of complex systems include: installations, organizations, communities, etc. With the understanding of resilience as ability to withstand and 'bounce back' from major disruptive events, the course will consider resilience as an emergent attribute, and investigate some pre- and post-event approaches to resilience enhancement. The focus of the mathematical modeling techniques presented in this course will be on nonlinear dynamics. We will also discuss relevant variational optimization techniques that can be used to guide measures taken to enhance resilience. The course will include selected applications as case studies; examples include: savanna ecosystems, large installations, communities facing infectious diseases, preparation for and response to coastal storms, etc. Prerequisite(s): Differential Equations.

EN.575.770. Global Health Engineering. 3 Credits.