EN.575 (ENVIRONMENTAL PLANNING AND MANAGEMENT)

EN.575.608. Optimization Methods for Public Decision Making. 3 Credits.
This course is an introduction to operations research as applied in the public sector. Public sector operation research involves the development and application of quantitative models and methods intended to help decision makers solve complex environmental and socio-economic problems. The course material is motivated by real-world problems and is presented in an environmental engineering-relevant context. Such problems include air pollution control, water resources management, transportation planning, scheduling, resource allocation, facility location, and biological conservation. Emphasis is placed on skill development in the definition of problems, the formulation of models, and the application of solution methodologies. Methodologies covered in this course include linear programming, integer programming, multiobjective optimization, and dynamic programming.

EN.575.611. Economic Foundations for Public Decision Making. 3 Credits.
The course examines intermediate-level price theory and surveys applications to public-sector decision making. Topics include demand, supply, behavior of the market, and introductory welfare economics. Applications include forecasting, cost-benefit analysis, engineering economics, and public sector pricing.

EN.575.628. Business Law For Engineers. 3 Credits.
This course introduces engineers to the basic legal principles they will encounter throughout their careers. Course discussions cover contracts (formation, performance, breach, and termination), corporations and partnerships, insurance, professional liability, risk management, environmental law, torts, property law, and evidence and dispute resolution. The course emphasizes those principles necessary to provide engineers with the ability to recognize issues that are likely to arise in the engineering profession and introduces them to the complexities and vagaries of the legal profession.

EN.575.635. Environmental Law for Engineers & Scientists. 3 Credits.
This course explores fundamental legal concepts relevant to environmental issues, including the relationship between statutes, regulations, and court decisions. Also included are various forms of enforcement used in environmental rules: command and control, liability, and information disclosure. Specific issues include criminal enforcement, a survey of environmental statutes, regulations and case law, the purpose and misconceptions surrounding environmental audits and assessments, the concept of attorney-client privilege, unauthorized practice of law, and ethical conflicts between the attorney and engineer/scientist roles.

EN.575.637. Environmental Impact Assessment. 3 Credits.
This course examines principles, procedures, methods, and applications of environmental impact assessment. The goal of the course is to promote an understanding of how environmental impact assessment is conducted and used as a valuable tool in the engineering project management decision-making process. Topics include an overview of environmental impact assessment; selection of scientific, engineering, and socioeconomic factors in environmental impact assessment; identification of quantitative and qualitative environmental evaluation criteria; application of traditional and other techniques for assessing impacts of predicted changes in environmental quality; approaches for identifying, measuring, predicting, and mitigating environmental impacts; modeling techniques employed in environmental impact assessment; environmental standards and the environmental impact assessment process; and methodologies for incorporating environmental impact assessment into management decision-making. Students learn to prepare an environmental impact assessment, review and critically analyze an environmental impact statement, use mathematical models for environmental impact prediction, and apply environmental impact assessment as a tool in management decision-making. Case studies of environmental impact assessment for several types of engineering projects are employed.

EN.575.640. Geographic Information Systems (GIS) and Remote Sensing for Environmental Applications. 3 Credits.
Through lectures and laboratory exercises, this course illustrates the fundamental concepts of GIS and remote sensing technologies in the context of environmental engineering. Topics include the physical basis for remote sensing, remote sensing systems, digital image processing, data structures, database design, and spatial data analysis. The course is not intended to provide students with extensive training in particular image processing or GIS packages. However, handson computer laboratory sessions re-enforce critical concepts. Completion of a term project is required.

EN.575.658. Natural Disaster Risk Modeling. 3 Credits.
Natural hazards such as floods, earthquakes, and hurricanes exert a heavy toll of victims and economic losses every year. Yet, concentrations of population in hazard-prone-areas, the growth of infrastructure and climate change are aggravating the risk of future losses. Consequently, adequate interventions must be implemented to mitigate the damaging effects of natural hazards. To do this, public agencies, non-profits, and companies formulate mitigation actions such as emergency preparedness plans and building retrofits. Catastrophe models are tools to inform all these efforts, which simulate the socioeconomic risk resulting from the interaction of geophysical events and the spatial distribution of infrastructure.

EN.575.707. Environmental Compliance Management. 3 Credits.
The course covers compliance with environmental laws and regulations by industry, small business, government facilities, and others. It includes legal responsibilities, environmental management systems, and practices such as audits and information systems and development of corporate policies and procedures that rise to the daunting challenge to harmonize the institution's primary goals with its environmental obligations. Several dimensions of environmental management are discussed: federal, state, and local regulation; scientific/technical factors; public relations and the press; and institutional objectives including economic competitiveness.

EN.575.710. Financing Environmental Projects. 3 Credits.
This course treats the financing of projects from two complementary perspectives: that of a government agency funding source, and that of an environmental utility (water, wastewater, solid waste) that needs funds for its project. It discusses grants, concessionary loans, market loans, and loan guaranties, along with their relative desirability and efficiency. Since grant funding is never available for all projects, the course deals extensively with borrowing/lending. It discusses strategies for maximizing utility income, including appropriate tariff structures and the reform of government subsidy policy from supply-based general subsidies to demand-based targeted subsidies. Operational strategies to maximize income are also discussed, such as techniques to improve billing and collections, reduce losses, and reduce energy costs. Traditional cash flow analyses are used to determine debt service capabilities. Various project cost reduction strategies, such as staging and scaling, are introduced. Grants in the form of upfront project cost buy-downs vs. annual debt service subsidies are compared. Finally, several examples of project financings combining many of the elements introduced during the course are presented and analyzed.

EN.575.711. Climate Change and Global Environmental Sustainability. 3 Credits.
This is a multidisciplinary course that focuses on the critical assessment of science, impacts, mitigation, adaptation, and policy relevant to climate change and global environmental sustainability. The first half of the course introduces students to climate change including impacts and drivers, modeling science, mitigation and adaptation efforts, and social aspects (public opinion, responsibility, etc.). The second half of the class considers how climate change and sustainability relate and explores key sustainability concepts and trade-offs related to sustainability's three pillars of economy, society, and environment. Students will explore course concepts through a combination of materials including news and digital media and press, domestic and international technical reports, and peer-reviewed scientific literature. Discussions will include both physical and social considerations and cover a wide range of sectors (e.g., water, energy) and levels of governance (local, regional, national, international). Students will be required to use both subjective and objective analyses of course concepts through employing critical thinking strategies and active learning. Course assignments will include a combination of discussions, presentations, readings, and interactive exercises.

EN.575.714. Water Resources Management. 3 Credits.
This multidisciplinary course examines the scientific, institutional, and analytical aspects of managing water quantity and quality. Students are provided a historical context that is useful for assessing current policy. The water cycle and basic hydrology are reviewed. The course surveys the laws and regulatory instruments for managing water quantity and quality, which operate across federal, state, and local levels of government. Funding issues associated with water resources management include operating and capital budgets, debt financing, the challenges of pricing, and the role of privatization. The course addresses the management of water supply and demand in the United States by economic sector and by in-stream and off-stream uses. This includes trends in water supply and demand, as well as modeling methods for water supply management. Fundamentals of flood and drought management are covered, with attention given to the context of global climate change and extreme events. The critical role of the general public in water resource management decision making is addressed in the context of structured techniques involving economic analyses, multiobjective analyses, and collaborative decision making. Water quality-based management under the federal Clean Water Act includes the topics of water quality standards, water quality assessments, total maximum daily loads (TMDLs), and ensuing permit requirements. Regional ecological water resources management is addressed for the Susquehanna River and by contrasting the Chesapeake Bay case with other largescale cases.

EN.575.723. Sustainable Development and Next-Generation Buildings. 3 Credits.
The course will introduce the concepts, applications, and tools for analysis and decision making in support of sustainable environmental development and next-generation communities and building design. Students will be introduced to a variety of challenges related to environmental protection, stewardship, and management of air, soil, and water. The underlying principles of ecological protection, stewardship, reduced environmental footprint, ecosystem capital, sustainable economic development, and globalization impacts will be reviewed. The integration of actions that are ecologically viable, economically feasible, and socially desirable to achieve sustainable solutions will be evaluated. Within this context, the course will explore sustainable building concepts that are intended to provide, throughout their lifetime, a beneficial impact on their occupants and their surrounding environment. Such buildings are optimally integrated on all parameters-initial affordability, timeliness of completion, net life-cycle cost, durability, functionality for programs and persons, health, safety, accessibility, aesthetic and urban design, maintainability, energy efficiency, and environmental sustainability. The principles of LEED building design and certification will also be introduced with a review of example projects. Integrated design and construction practices that significantly reduce or eliminate the negative impact of buildings on the environment and occupants will be assessed in the broad areas of (1) sustainable site planning, (2) safeguarding water and water efficiency, (3) energy efficiency and renewable energy, (4) conservation of materials and resources, and (5) indoor environmental quality. A critical element for a successful sustainable building policy and program is an integrated building planning and design process. Integrated planning and design refers to an interactive and collaborative process in which all stakeholders are actively involved and communicate with one another throughout the design and construction practice. These processes will also provide a broader understanding of sustainable options for infrastructure changes that may occur in various BRAC planning and implementation situations. A number of case studies will be examined to gain an understanding of application issues.

EN.575.731. Water Resources Planning. 3 Credits.
The course will discuss the application and interrelationships among microeconomics, ecology, hydrology, and fields related to the planning and management of water systems. Topics will include flood control, navigation, hydroelectric power, water supply, environmental restoration, multi-objective planning, and urban water resource management. The course will demonstrate the process for planning a water resource project, including identifying the problems and opportunities, inventorying and forecasting conditions, formulating alternative plans, evaluating alternative plans, comparing alternative plans, and selecting a plan. Particular attention will be paid to the appropriate interdisciplinary approach to plan formulation.

EN.575.733. Energy and the Environment. 3 Credits.
This course examines the interrelationships between the environment and the ways in which energy is produced, distributed, and used. Worldwide energy use patterns and projections are reviewed. Particular attention is paid to the electrical and transportation sectors of energy use. Underlying scientific principles are studied to provide a basis for understanding the inevitable environmental consequences of energy use. Topics studied include fossil, nuclear, and existing and potential renewable sources, including hydroelectric, geothermal, tidal, wind, and solar. Transportation options including internal combustion, hybrid, and electric options are quantitatively compared. Use of alternate fuels such as biodiesel and ethanol are evaluated. Emphasis is placed on the environmental impacts of energy sources, including local effects resulting from emissions of nitrogen oxides, sulfur, hydrocarbons, and particulates as well as global effects such as mercury release from coal combustion. Carbon emissions are a continuing theme as each energy technology is studied and its contribution to climate change is assessed. Carbon suppression schemes are examined. Particular attention is paid to consequences and effectiveness of government intervention and regulation. The purpose is to help students understand how energy is converted into useful forms, how this conversion impacts our environment, and how public policy can shape these impacts.

EN.575.734. Smart Growth Strategies for Sustainable Urban Development and Revitalization. 3 Credits.
This course addresses the concepts, practices, and tools for smart growth sustainable urban planning and provides an understanding of how to apply these to urban communities. The sustainable urban development is a pattern of resource use that aims to meet human needs while preserving the environment so that these needs can be met not only in the present but also for future generations to come. In other words, it is the development and restoration of urban areas that will meet the needs of the present without compromising the ability of future generations to meet their own needs. The course addresses a number of urban design concepts for smart growth and sustainable development, including balanced land use planning principles; importance of an overall transportation strategy; providing urban tree coverage; leveraging public transportation accessibility; providing a spectrum of housing availability; integration of office, retail, and housing units; reduction of urban area environmental footprint; use of recycled, reused, reusable, green, and sustainable products; integration of renewable solar energy and wind power into buildings and government systems; transit-oriented development; innovative low-impact storm water management practices; reduction in urban heat island effects; urban water resource management; and energy efficiency and conservation.

EN.575.735. Energy Policy and Planning Modeling. 3 Credits.
This course provides students with comprehensive knowledge on methods for optimizing operation and design of energy systems and methods for analyzing market impacts of energy and environmental policies with emphasis on both theory and solution of actual models. The course also covers linear and nonlinear programming and complementarity methods for market simulation. Prerequisite(s): Microeconomics or optimization methods (linear programming).

EN.575.736. Designing for Sustainability: Applying a Decision Framework. 3 Credits.
In this course, students will apply a sustainability decision framework, developed by the National Research Council, to an environmental project of their choice. This will include developing a project management plan, a project action plan, and an evaluation and adaptation assessment that will outline how sustainability principles will be incorporated into their project. This applied approach will give students experience in systems thinking, linkages across governmental bodies, development of indicators, use of environmental support tools, transdisciplinary cooperation, and the use of structured decision framework.

EN.575.737. Environmental Security with Applied Decision Analysis Tools. 3 Credits.
This multi-disciplinary course examines current and emerging environmental security issues at multinational, national, and regional scales. These issues are approached from the perspective of decision-making for policy, planning, and management. The course begins with an overview and definitions of environmental security within the context of present global demographic patterns, use of natural resources, and climate change. The theory and principles of multi-criteria decision analysis (MCDA) are reviewed, using environmental security examples to illustrate concepts. Three MCDA methodologies are presented, including multi-attribute weighting, Analytic Hierarchy Process, and outranking, which are commonly used to assist decision makers. The MCDA approach is critiqued from the perspective of measurement theory and guidelines for MCDA use are suggested. With both the social sciences and natural sciences providing a framework, several specific environmental security topics are covered in greater depth: energy; air quality; ecosystems and biodiversity; fresh water; agriculture and food; and sea level rise. Within these topics, students will develop MCDA models for particular policy, planning, and management problems under the guidance of the instructors. The course concludes by considering the prospects for environmental security and sustainability in the coming decades.

EN.575.738. Transportation Innovation and Climate Change. 3 Credits.
The world stands at the cusp of an unusually dynamic period in transportation's journey to the future. Legacy technologies coexist with powerful forces pushing forward revolutionary innovation. While cars and other vehicles using conventional fuels are forcing climate change, transportation innovations such as electric and automated vehicles to smart infrastructures are creating new lifestyles where transportation reduces carbon emissions. Transportation innovation creates technological and societal "tipping points" that will transform transport. Nevertheless, the direction and consequences of these "tipping points" are yet to be determined. In this class, students will test this thesis via the use of explanatory theories, risk models, and the evaluation of case studies of transport innovation. The use of these theories and tools will facilitate a more rigorous approach to anticipating the unintended, synergistic, and circular (feedback) effects of transportation innovation processes. Likewise, students committed to entering the fields of environmental planning and management will learn how to identify innovation strategies more likely to satisfy future unanticipated conditions and challenges. This course is divided into the following topics: 1) Mechanisms of climate change, 2) Role and efficacy of climate models, 3) Legacy transportation technologies versus revolutionary transportation innovations, 4) Assessing alternative climate change futures through existing patterns of technological change and transportation innovation, 5) Identifying exogenous and endogenous threats and 6) Planning for the future through tools borrowed from a variety of disciplines (e.g., public participation, uncertainty and complexity studies, innovation roadmaps, and portfolio management).

EN.575.747. Environmental Project Management. 3 Credits.
This course educates students on the key elements of an integrated approach to environmental project management, an endeavor that requires expertise in scientific, engineering, legal, public policy, and project management disciplines. Emphasis is placed on critical factors that are often unique to a major environmental project, such as the uncertainty surrounding scope definition for environmental cleanup projects and the evolving environmental regulatory environment. The students learn to develop environmental project plans, establish project organization and staffing, define management functions, develop time management approaches, resolve project conflicts, determine project effectiveness, and implement integrated project management techniques such as the Program Evaluation and Review Technique (PERT) and the Critical Path Method (CPM) as they relate to environmental project management, perform pricing and cost estimating, establish cost control, set priorities, and perform trade-off analyses. The course uses environmental project case studies to examine the integrated nature of environmental project management. Examples of topics to be covered in this case study format include environmental security projects, environmental technology deployment projects, privatization of governmental environmental projects, and pollution prevention/waste minimization projects.

EN.575.750. Environmental Policy Needs in Developing Countries. 3 Credits.
This course will provide students with a thorough understanding of environmental policy needs in developing countries. The world's fastest growing economies are located in developing countries where rapid urbanization and use of natural resources will require supporting infrastructure. However, there are factors that may encourage or limit this growth, including the country's economic structure, governance, cultural history, demographics, and social structure. Through lectures, research, and group exercises, the students will (1) explore the social, economic, and environmental issues that challenge countries in the developing world as they move toward advancing their economies, infrastructure, and governance systems; (2) analyze how the various issues are interconnected and understand how this interconnectedness may affect environmental policy making; and (3) apply critical thinking to the analysis of environmental policy in order to effectively challenge classical assumptions. The student will be expected to analyze a specific environmental issue facing a developing country or region and develop a policy framework to address this issue.

EN.575.752. Environmental Justice and Ethics Incorporated into Environmental Decision-Making. 3 Credits.
This course focuses on the environmental justice and ethics problems facing environmental engineers, planners, and managers. It explores the foundations of the environmental justice movement, current and emerging issues, and the application of environmental justice analysis to environmental policy and planning. It examines claims made by diverse groups along with the regulatory and government policy responses that address perceived inequity and injustice. The course will study the mechanisms that give rise to class, racial, and other kinds of disparities that impact environmental decision-making. This includes the study of affected constituents, communities, industry, government, environmental activists, policy makers, and scholars, allowing students to learn about the causes and consequences of inequitable distributions of environmental benefits and hazards. Students will learn about various methods for researching environmental justice issues and strategies for formulating policies and collaborating with communities. In this course, students will review environmental justice theories and perspectives through case studies of Black Americans, Hispanic Americans, and Native American Nations. The class will focus mainly on the United States, but will include aspects of international issues and perspectives through research projects.

EN.575.753. Communication of Environmental Information and Stakeholder Engagement. 3 Credits.
This course provides students with the skills for communicating scientific environmental data and sustainable engineering design to stakeholders, including scientists in different fields, policy decision makers, and the interested public. The course covers the importance of clear communication of complex scientific information for the development and acceptance of technologies, public policy, and communitybased environmental initiatives. The key stakeholders for environmental engineers, scientists, and managers are specified. Methods of engagement and designing key messages are defined for global, national, and local issues of student interest. Major types of communication media are covered, including written communication and graphics, online communications in short- and long-form new media, and interactive communications such as surveys and citizen science to involve stakeholders in the creation and analysis of big data and dispersed information. The emphasis of the course is from the point of view of an environmental professional (not a marketing professional) and developing an effective sciencebased communications portfolio to share complex scientific information with a broad range of interested parties.

EN.575.759. Environmental Policy Analysis. 3 Credits.
The course explores the process of analyzing environmental policies to ensure human health, that environmental needs are protected, and that the physical environment is preserved, protected, and restored, if necessary. Emphasis is placed on the need to evaluate and make decisions regarding environmental science, human health, sociopolitical, technological, legal, and economic considerations in a context of incomplete information and uncertain futures. Case studies and policies relating to various contemporary environmental issues, for example hazardous waste disposal, natural resource extraction and preservation of natural resources, are critiqued during the semester. The course will lead students through the various steps of the policy analysis process. Students are expected to evaluate policy alternatives, develop evaluation criteria, and apply qualitative and quantitative methods to determine consequences, trade-offs, and potential synergies relating to these environmental issues. Students will then use these skills to create and execute an individual research project that analyzes an environmental policy relating to a specific issue of interest to them, evaluating potential responses to environmental management problems through analyzing the impacts of each policy alternative.