EN.575 (ENVIRONMENTAL PLANNING AND MANAGEMENT)

Courses

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 provides a thorough review and application of the Environmental Impact Assessment (EIA) process and the National Environmental Policy Act (NEPA.) It covers selection of scientific, engineering, and socioeconomic factors in EIA; identification of quantitative and qualitative environmental evaluation criteria; EIA life cycle application of techniques for assessing impacts of predicted changes in environmental quality; approaches for identifying, measuring, predicting, and mitigating environmental impacts; modeling techniques as employed in EIA; environmental standards in the EIA process; sustainable development goals (SDG) as applied to EIA, methodologies for incorporating EIA into management decision-making. EIA alignment with climate change and Diversity, Equity, and Inclusion (DEI) as related to EIA are addressed. Case studies of EIA for several types of engineering projects are employed. Students acquire the knowledge to prepare an EIA, critically review and analyze an EIA, apply EIA as an important tool in management decision-making processes and develop a comprehensive analytical example of an Environmental Impact Statement (EIS).

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 course examines the technical, economic, and social aspects of managing water resources. A review of water fundamentals involving physical, chemical, and biological systems provides a foundation. Students are given a historical basis for thinking about and resolving contemporary challenges. Observed and predicted climate change impacts on water resources are explored along with management implications and responses. Key water law concepts, their roots in social institutions, and current traditional institutions are covered. The course surveys regulatory instruments, like permits, and their operation across federal, state, and local levels of government. Funding and financing issues are covered. The course addresses the management of water supply and demand in the United States. Fundamentals of flood and drought management are covered, with attention given to climate change. 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 implications for permit requirements. Regional ecological water resources management is addressed by contrasting the Chesapeake Bay case with other cases. The topic of natural environmental flows explores the benefits of natural flow variability and the interrelationships among five key functions that characterize the health of a stream and support stream restoration design. Water resource management decision making is addressed in terms of structured techniques involving economic analyses, multi-objective analyses, and collaborative decision making with a focus on the role of public involvement. Students will be led in the development of a well-defined, substantive water resources management research question as part of a course project.

EN.575.722. Principles of Air Quality Management. 3 Credits.
Air quality management is fundamental to human health and environmental stewardship. This course provides a systematic introduction to the air quality management cycle and how it is applied to protect both outdoor and indoor air quality as well as to mitigate climate change. Air pollutants pose risks at multiple spatial scales—from individual homes to regional and global geographies—and across various timelines—from hours to decades. This course describes the formation, transport, and transformation of air pollution and reviews the historical development of air pollution control programs. As science and technology evolve, the principles of air quality management enhance our ability to protect and restore healthful air quality and address both long-standing and emerging issues. Students will learn how air quality management principles shape and enable a variety of strategies to minimize negative impacts of traditional and newly developed air contaminants. Assignments emphasize analyzing air quality measurements and emissions data as well as comparing and contrasting regulatory approaches. Through a term project students apply knowledge of the principles of air quality management to timely and relevant air quality issues.

EN.575.723. Environmental Sustainability 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. Also, a further critical element being addressed for a successful sustainable building policy and program is an integrated building planning and design process.

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 Cities. 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. This course explores transportation innovation at the "systems" level to determine whether or not we are bound to the past or moving actively towards a new future. The course assesses uncertainties regarding the capacity to innovate at a rate that will stimulate sustainability, resilience, and livability. 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. This course covers the following topics: mechanisms of climate change; role and efficacy of climate models; legacy transportation technologies versus revolutionary transportation innovations; assessing alternative climate change futures through existing patterns of technological change; identifying exogenous and endogenous threats; and 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). Because new policies and practices depend on innovation, the course includes group projects designed to build skills for evaluating the direction of innovation over the short, mid, and long-term and the inherent capacity of a particular locality or region to contribute to systemic technological change.

EN.575.747. Environmental Project Management. 3 Credits.
This course provides students with the knowledge for an integrated approach to environmental project management, applying pertinent scientific, engineering, legal, public policy, and project management disciplines. Emphasis is placed on factors that are common to an environmental project, such as external impacts, stakeholder conflicts, scope uncertainty, and the evolving environmental regulatory environment. The students learn the elements of environmental project plans, including project organization and staffing, schedule dependencies and optimization, cost estimating and control, and communication with internal and external stakeholders. The types of environmental projects addressed include infrastructure, restoration and remediation, program development, and alternatives analysis. Project Management Institute materials are utilized, along with case studies, to illustrate actual project conflicts, necessary adjustments, and successes.

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.575.751. Environmental Justice, Climate, and Health Equity. 3 Credits.
Environmental planners are uniquely positioned to address climate change, environmental health, and health equity. The will course lectures and applied exercises will offer students a first-hand experience assessing the impact of environmental planning on climate and public health and the impact of environmental justice movements in the United States and globally. Students will harness evidence-based practices with community stakeholders to address emerging environmental and public health challenges. These applied exercises with community stakeholders will reinforce seminal course concepts.

EN.575.752. Environmental Decision-Making: Climate, Energy, Indigenous Populations, and Accessibility. 3 Credits.
This course focuses on the practical decision-making challenges facing environmental engineers, planners, and managers when implementing programs and projects from creation to completion. It begins by exploring the foundations of the energy and climate justice movements in terms of current and emerging issues, Accessibility and indigenous rights are examined for practical factors impacting effective implementation of projects. Students are required to focus on the praxis of solutions for effective decision-making approaches for including diverse stakeholders as part of their management approach. This course 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, ableism and other kinds of disparities that impact environmental decision-making which can be barriers to achieving the sustainability development goals that broadly involve these stakeholders. This includes the study of affected constituents, communities, industry, government, activists, policy makers, and scholars, allowing students to learn about the causes and consequences of inequitable distributions of benefits and hazards. Students will learn about various methods for researching climate and energy justice issues and strategies for formulating policies and collaborating with communities. In this course, students will review theories and perspectives through case studies of Black Americans, Latinas, Asians, disability, and indigenous communities. The class will focus mainly on the United States but will include aspects of international issues and perspectives through assignments. There will be flexible options for students to participate in game simulations on climate justice and sustainability issues and when possible, include international participants and guest squeakers from these diverse communities.

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.

EN.575.771. Data Analytics in Environmental Health and Engineering. 3 Credits.

Data analytics is a field of study involving computational statistics, data mining and machine learning, to explore data sets, explain phenomena and build models for inference and prediction. The course begins with an overview of some traditional analysis approaches including ordinary least squares regression and related topics, notably diagnostic testing, detection of outliers and methods to impute missing data. Next comes nonlinear regression, and regularization models including ridge regression. Generalized linear models follow, emphasizing logistic regression and including models for polytomous data. Variable subsetting is addressed through stepwise procedures and the LASSO. Supervised machine learning topics include the basic concepts of resampling, boosting and bagging and several techniques: Decision Trees, Classification and Regression Trees, Random Forests, Conditional Random Forests, Adaptive Boosting, Support Vector Machines and Neural Networks. Unsupervised approaches are addressed through applications using principal component analysis, k-means Clustering, Partitioning Around Medoids and Association Rule Mining. Methods for assessing model predictive performance are introduced including Confusion Matrices, k-fold Cross-Validation and Receiver Operating Characteristic Curves. Environmental and public health applications are emphasized, with modeling techniques and analysis tools implemented in R.