AS.420 (ENVIRONMENTAL SCIENCES)

AS.420.301. Quantitative Methods. 3 Credits.
This prerequisite course provides the necessary background in mathematics for students who do not have sufficient undergraduate course work in calculus and statistics. Students who receive a provisional admission because of math deficiency can opt to take the mathematics assessment test. If the student earns a score of 80% or better, then s/he is not required to take the course. In this course, students acquire quantitative skills and an understanding of mathematical principles fundamental to environmental sciences, and necessary for evaluating the implications of policy measures. Topics include probability and statistics, systems of equations, analytical geometry, and basic concepts of calculus. Problem sets, interpretation of data, and applications to everyday problems help students appreciate the usefulness of quantitative methods. Offered online twice a year.

AS.420.302. Chemistry of Natural Processes. 3 Credits.
This course provides students with a basic understanding of the fundamentals of chemistry, of Earth's interrelated chemical systems, and of how to manipulate and interpret chemical data. Topics include molecules and chemical bonding, states of matter, thermodynamics, and kinetics. Through a series of exercises, students apply chemistry principles to solve real-world environmental problems. Prerequisite: Students are urged to take 420.301 Quantitative Methods for Environmental Sciences before enrolling in this course. Offered online only, one to two times annually.

AS.420.601. Geological Foundations of Environmental Science. 3 Credits.
This course provides an overview of Earth's materials, processes, and resources for environmental scientists and policymakers. Topics include minerals, rocks, sediments, stratigraphy, structure, geomorphology, and geologic environments. Emphasis is placed on understanding geologic principles and methods as applied to environmental science, Earth resources, and public policy. Offered online or onsite, twice per year. Onsite version includes a required field trip.

AS.420.603. Environmental Applications of GIS. 3 Credits.
Geographic information systems technology (GIS) is a powerful data visualization and analysis tool.This course is designed to introduce students to advanced concepts of geographic information science related to the fields of reserve planning, environmental science, natural resources, and ecology for the purpose of spatial analysis and geo-visualization of environmental issues. Topics may include conservation needs using remote sensing, digital image processing, data structures, database design, landscape ecology and metrics, wildlife home range and habitat analysis, suitability modelling, terrain and watershed analysis, and spatial data analysis. This course will only be offered online.

AS.420.604. Hydrology & Water Resources. 3 Credits.
This course provides an introduction to the hydrological cycle and examines the influence of climate, geology, and human activity on this cycle. The components comprising this cycle will be examined and include: precipitation; evapotranspiration; surface and groundwater flow; storage in natural reservoirs; water quality; and water resource management and regulation. Discussion of these topics in threaded discussions using the primary literature as well as problem sets will highlight applications and areas of current hydrological research. Offered online and onsite three times per year. Onsite version includes a required field trip.

AS.420.605. Maritime Law and the Environment. 3 Credits.
The course is designed to introduce students to the process by which environmental policy can be implemented as law in the international sphere. "Law of the Sea" formed the foundation of modern public international law. It also represents the world's first efforts to define and regulate a "global commons" and to grapple with the management of resources as the "common heritage of mankind". Topics explored include freedom of navigation on the high seas, the limits on port-state jurisdiction over foreign vessels, and the scope of coastal nations' power to regulate activities in their respective territorial waters, "contiguous zones", and "exclusive economic zones". The course also examines how the UNCLOS regime functions in tandem with other treaties, customary international law, the role of voluntary standards (such as American Society for Testing and Materials (ASTM) International and International Organization for Standardization (ISO)) and domestic law in addressing specific current issues - including management of living and nonliving resources on the Continental Shelf, deep seabed mining, reduction of pollution, protection of highly migratory fish stocks, aquaculture, "marine dead zones", and the future of ocean policy.

AS.420.606. Climate Justice. 3 Credits.
Climate change impacts and policies effect different groups of people in varying ways. More vulnerable populations will disproportionately experience impacts more severely (drought, flooding, food security, storms, heat islands, changes to resources and livelihoods). Also, policies to mitigate and adapt to climate change will have differential impacts. In this course, we will review both climate impacts and proposed policies through the lens of equity and justice. Topics to cover will include: analysis of differential impacts, equity critique of mitigation policies, and the impact of adaptation policies on the poor and people of color. The course will cover both the US and international topics.

AS.420.608. Oceanic & Atmospheric Processes. 3 Credits.
In this course, students study the oceans and the atmosphere as interrelated systems. The basic concepts of air masses, water masses, winds, currents, fronts, eddies, and storms are linked to permit a fundamental understanding of the similar nature of oceanic and atmospheric processes. Among the course's topics are weather forecasting, global climate change, marine pollution, and an introduction to applied oceanography. A field trip is included for in-person sections. Offered on-site or online two to three times each year.

AS.420.609. Agroecology. 3 Credits.
In this course, Agroecology will be taught as a transdisciplinary study of how agricultural production of plants and animals affects and is affected by the local environment. Students will gain a more in-depth understanding of inputs and outputs in agricultural systems and their relation to primary productivity, nutrient cycling, energy flows, and species interactions on farms. The components of farm management will be studied within the context of a complex ecosystem. Time in this course will be spent in lecture, field studies and field trips that will attempt to integrate concepts in agroecology with actual practices in sustainable agriculture.

AS.420.610. Sustainable Business. 3 Credits.
This course provides an introduction to sustainable business strategies practiced by US companies. Students will examine the evolution of CSR and triple bottom line management in the context of competing stakeholder interests. Given that sustainability practices differ by sector, company and country, specific illustrations will be discussed in relation to deforestation, water and waste. Attention will be placed on evolving regulatory regimes including compliance mechanisms such as certification and auditing as well as voluntary partnering with NGO's and government agencies. The discussion of sustainable business strategies will be approached as a policy debate that continues to be shaped at both the national and global levels.

AS.420.611. Principles & Methods of Ecology. 3 Credits.
This course examines the relationship between organisms and their biotic and abiotic environment at three levels of biological hierarchy: individual organism, population, and community. Population characteristics, models of population dynamics, and the effect of ecological interactions on population regulation are discussed in detail. The structure and function of natural and man-made communities and the impact disturbances have on community structure are also examined. Students are led to appreciate the importance of ecology in solving environmental problems. Offered online or onsite, at least twice per year. Onsite version includes required field trips.

AS.420.612. Sustainability Science: Concepts and Challenges. 3 Credits.
Sustainability Science is an interdisciplinary field engaged with understanding the dynamics between natural and social systems and how those interactions challenge the notion of sustainability. This course will start by reviewing the history of the concept of sustainability and will then consider how it has been applied in the environmental sciences. Specifically the goal of the course is to provide a comprehensive, multidisciplinary perspective on this emerging field, understanding its theory, research horizons, and practical applications. Concepts to be reviewed include socio-environmental systems, complex adaptive systems, cross-scalar impacts, tipping points and regime shifts, vulnerability, resilience and adaptive capacity, equity, sustainable development, political ecology, governance, capital assets and livelihoods. In a seminar context this course will consider these and other concepts from a theoretical perspective but will focus on their application in solving real-world problems.

AS.420.613. Forest Ecosystems. 3 Credits.
Forests are critical global ecosystems that provide not only timber and wood products, but an array of services including habitat for wildlife, water filtration, carbon storage, and recreational opportunities. Forests are also dynamic landscapes produced by complex and interacting social and ecological processes. Yet increasingly they are being impacted by deforestation, climate change, biotic homogenization, the spread of invasive species and a range of other natural and anthropogenic stressors. This graduate discussion based seminar class will explore the distribution, ecology and sustainability of forest ecosystems with an eye on development of forests of North America over time. It will cover aspects of biogeography, climate forcing of vegetation dynamics, effects of invasive species, land use change and creation of urban forests. Prerequisites: Principles and Methods of Ecology or equivalent experience.

AS.420.614. Environmental Policymaking and Policy Analysis. 3 Credits.
This course provides students with a broad introduction to U.S. environmental policymaking and policy analysis. Included are a historical perspective as well as an analysis of future policymaking strategies. Students examine the political and legal framework, become familiar with precedent-setting statutes such as NEPA , RCRA , and the Clean Air and Clean Water Acts, and study models for environmental policy analysis. Cost benefit studies, the limits of science in policymaking, and the impact of environmental policies on society are important aspects of the course. A comparison of national and international policymaking is designed to provide students with the global perspective on environmental policy. Offered online or onsite, at least twice per year.

AS.420.615. Environmental Restoration. 3 Credits.
This field-centered course focuses on river, freshwater tidal wetland, serpentine and deforested grassland environments that have been restored or designed in the southern Pennsylvania, Maryland and DC region. Knowledge of prehistoric and paleoecological conditions and post-settlement impact along with modern ecological studies provide important long-term guidelines for restoration, mitigation and conservation measures. Field trips are an integral component of this course with possible locations to include Gettysburg Battlefield, PA; Soldiers Delight Environmental Area, Little Falls and First Mine Run in northern Baltimore County; Big Spring Run Restoration in Lancaster, PA; Severn River Coastal Plain forest, sweet bay magnolia bog and cedar bog in Anne Arundel County; and the restored Kenilworth Marsh in DC. Weekly classroom sessions include plant identification of grasses, sedges and trees, and background data on vegetation, land use history and paleoecological data. The pros and cons of different restoration and conservation approaches regarding effectiveness and sustainability are reviewed. Prerequisite: 420.611 Principles and Methods of Ecology, equivalent course, or experience.

AS.420.616. Environmental Consequences of Conventional Energy Generation. 3 Credits.
Environmental consequences of conventional energy generation will explore the energy resources that have driven and are projected to be the primary energy sources worldwide for the next several decades. Specifically, this course will focus on the historical and future role of conventional energy sources such as those derived from fossil fuels, focusing on their geologic genesis and the consequences of resource extraction which will invite comparisons to more recent trends in energy generation. Students will be exposed to the nexus of social, technical, engineering and environmental challenges of providing energy supplies to an increasingly urban and technologically connected global population. Topics include petroleum, traditional natural gas, coal, nuclear, hydroelectric, and geothermal supplies as well as recent trends in shale hydrologic fracturing methods of obtaining petroleum resources. Environmental impacts will focus on mining, resource extraction, soil and groundwater contamination as well as particulates, smog, acid rain, and global warming. Global production, distribution, usage and impacts of these resources will be considered. Offered online, annually. Prerequisites: none.

AS.420.617. Managing Responsible Organizations for the Ecosystem. 3 Credits.
Corporations are currently in the forefront of the sustainability debate with business viewed as a primary player in determining the future of the ecosystem. Leading businesses focused on sustainable strategies, implies changes across the conventional management processes of planning, organizing, leading and innovating. This course will examine the existing and emerging managerial approaches and individual competencies for sustainable management.

AS.420.618. Terrestrial and Marine Conservation Biology. 3 Credits.
Both the Maine coast and mountainous, interior Maine provide a stunning and ideal venue for learning about the myriad conservation biology issues, challenges and solutions in dealing with both marine and terrestrial conservation. These habitats provide an ideal "living laboratory" for studying, understanding and implementing conservation biology. Acadia National Park, established in 1919, will provide us opportunities to investigate the only fjord in the Atlantic Northeast, Somes Sound; carefully assess the ocean-land interface, e.g., Otter Cliffs, Thunder Hole, Sand Beach, and the Ocean Path Trail; hike Cadillac Mountain — the first place to see the sunrise from October to early March in the continental U.S.; time permitting visit Long Pond and hike the Ship Harbor Nature Trail; and spend a day "at sea" investigating cutting edge marine conservation issues up close. Additionally, day trips will be scheduled for the Schoodic Peninsula (via ferry from COA's dock to Winter Harbor) and to the new Katahdin Woods and Waters National Monument, just east of Mt. Katahdin, Maine's highest mountain — designated by President Obama as our newest National Monument in August 2016. Since this is a brand new Monument, we'll investigate how to help implement its mission including through a day hike assessing Katahdin Lake off the Loop Road. Prerequisite: 420.611 Principles and Methods of Ecology, equivalent course, or experience.

AS.420.619. Climate Dynamics. 3 Credits.
There is a huge interest in understanding the climate at multiple scales. This course will provide an overview of the chemical and physical climate system, feedbacks, and the basic physical balances governing atmospheric circulations and climate with an eye on understanding the basics of climate models. The course will cover energy transfer in the ocean-atmosphere system, mathematical modelling of the ocean and atmosphere, modeling of these systems and the basics on how to construct a climate model and explore the current state of climate models.

AS.420.620. Soils in Natural & Anthropogenic Ecosystems. 3 Credits.
This course introduces students to basic concepts of soil science and the soil's contribution to the functions of natural and anthropogenic ecosystems. It provides an overview of soil morphological, physical, chemical, and biological properties, and how these interact to form a soil with unique characteristics and ecosystem function. Students discuss soils of the world from the perspective of soil taxonomy, the processes that form these soils, and land use properties specific to each soil order. Students learn to read soil maps, to interpret and predict the quality and land use potential of soils, and to use available soil data. A strong focus will be given to environmental and ecological issues relating to soil science in the context of the ecological relationships between soil organisms and their biotic and abiotic environments, with emphasis on the role of soil organisms in biogeochemical cycling, ecosystem structure and function, long-term ecosystem sustainability, and global environmental change. Current issues regarding the proper use and management of soils are investigated. All sections (online and in person) will involve some field related work. Online sections will be offered every annually. Prerequisites: 420.601 Geological Foundations for Environmental Sciences; (recommended) 420.611 - Principles & Methods of Ecology, or permission from the instructor.
Prerequisite(s): Must satisfy prerequisite course (AS.420.611) prior to enrolling in AS.420.620

AS.420.622. Ecotoxicology. 3 Credits.
This course covers fundamental of ecotoxicology, including chemical action on plants, wildlife, and ecosystems. Coursework explores toxic effects of pollutants and other stressors at multiple levels of function ranging from cellular and organ systems to populations, communities, and ecosystem functions. Students will learn essential concepts governing fate, exposure, and toxic mechanisms of chemicals as well as basic mathematical models used to investigate biological uptake, bioaccumulation, and dose-response effects. Course includes lessons on application of ecotoxicology, including standard procedures for toxicity testing, risk assessment, and measuring exposures and impacts in the field. Topics are covered in a framework of basic biology and ecology, including cellular/organismal functions, trophic structure, food-web dynamics, population biology and community ecology. Offered online every two years. Prerequisite: 420.611 Principles and Methods of Ecology, equivalent course, or experience.

AS.420.623. Freshwater Ecology & Restoration of Aquatic Ecosystems. 3 Credits.
This course focuses on the ecology, protection, and restoration of non-tidal waters. Students study the biological, chemical, and physical characteristics of the waters and riparian zones. There is also a focus on ecological responses to anthropogenic activity and approaches to protection and damage mitigation in freshwater ecosystems. Ongoing and planned protection and restoration activities in Maryland and elsewhere are presented. Students develop holistic restoration plans based on existing ecological data. Two weekend field trips are required parts of the course. Offered every two years. Prerequisite: 420.611 Principles and Methods of Ecology.
Prerequisite(s): Must satisfy prerequisite course prior to enrolling in 420.623

AS.420.624. Ocean Stewardship and Sustainability. 3 Credits.
 Covering over 70% of our planet, the ocean produces half the planet's oxygen, absorbs a quarter of all carbon dioxide emissions, feeds 3 billion people, and contributes $3 trillion per year to the global economy. Yet, we know more about the moon's surface than we do about the bottom of the ocean. What we do know, however, is that overfishing, pollution, land-use change, and ocean warming and acidification, to name a few, are causing marine biodeterioration and threatening the ability of the ocean to sustain global systems critical for life. This course will provide students with a robust scientific approach to the study of oceans with a focus on environmental issues, governance and social-ecological systems.<o:p></o:p> This is an interdisciplinary course that examines the history of human interactions with ocean environments, current ocean sustainability issues, and real-world examples of how to advance ocean conservation practices and theories in the future. Students will investigate approaches to protect ocean ecosystems, to promote innovation in ocean governance, and to increase scientific knowledge, research and technology that supports ocean health. This course provides a holistic and systems-based view of how human interactions influence ocean functions and of innovative policies and sustainable management solutions to social and environmental problems stemming from those interactions. <o:p></o:p>
Prerequisite(s): Must satisfy the prerequisite course (420.608) prior to enrolling in AS.420.624

AS.420.625. Ecology and Ecosystem Management in Coastal and Estuarine Systems. 3 Credits.
This course examines the physical, chemical, and biological processes affecting coastal and estuarine ecosystems with special emphasis on the Chesapeake Bay as a model system. Human influences on such large and critical ecosystems and the policy decisions made to manage and minimize human impact are explored in lecture and seminar formats. Topics include the hydrodynamics of shallow tidal waters; energy and material flows and transformations; diversity and adaptation of plant, animal, and microbial communities; population and pollution ecology; and ecosystem management. Case histories illustrate problems in fisheries management and the eutrophication of the coastal and estuarine systems. Offered annually, on-site. Required weekend field trips are included. Prerequisite: 420.611 Principles and Methods of Ecology, equivalent course, or experience.

AS.420.626. Field Methods in Ecology. 3 Credits.
This course centers on practical field exercises to develop both technical proficiency and broader understanding of varied ecological systems. Field methods include quadrate, transect, and SAV sampling as well as multiple techniques for surveying animal communities and monitoring water quality. While analyzing their own data, students develop deeper understanding of fundamental concepts such as species-area curves, importance values, species diversity, and community similarity indices. Students also are introduced to paleoecological tools such as sediment coring. Several ecological processes including succession and the effect of disturbances on community structure are demonstrated. The significance, advantages, and disadvantages of various surveying methods are explored in classroom meetings, but for much of the course students conduct their studies in the forests, fields, and wetlands of the area. This course is offered onsite only with fieldwork scheduled for a succession of Saturdays; some sections may conduct field trips on one or two Fridays and/or Sundays. Offered most summers. Prerequisite: 420.611 Principles and Methods of Ecology, equivalent course, or experience

AS.420.627. Great Lakes Ecology and Management. 3 Credits.
This intensive course examines the physical, chemical, and biological aspects of the Great Lakes aquatic ecosystem as well as its governance, policy-making and management. State-of-the-science, socio-economic relationships, human impacts and restoration activities are also explored, often by presentations from regional experts. Daily lecture topics are reinforced with numerous field experiences to an array of sites throughout Michigan. Students will also be exposed to hands-on sampling, learn about long-term monitoring programs and participate in developing alternative management strategies.

AS.420.628. Ecology and Management of Wetlands. 3 Credits.
This course explores the biological, physical, chemical, and ecological aspects of tidal and non-tidal wetland ecosystems. Topics include wetland classification, valuation, function and dynamics. Wetland modification and manipulation are analyzed through case studies of restoration, construction, and mitigation. The effects of federal and state laws, of various regulations, and of human perturbations are explored. In-person sections include field trips that provide hands-on experience and demonstrate the significance of wetland mitigation, restoration and construction projects. Offered onsite every two years. Prerequisite: 420.611 Principles and Methods of Ecology, equivalent course, or experience.

AS.420.629. Drinking Water,Sanitation & Health. 3 Credits.
In this course students examine scientific and public policy dilemmas related to the provision of safe drinking water and related protection of global human health. Course work emphasizes basic understanding of the fundamentals of water supply, treatment, regulation, and sanitation as well as providing a focus on unresolved issues confronting scientists, resource managers, and policymakers. Students work to develop recommendations for solutions to critical issues as controlling pathogens from urban and agricultural runoff, managing harmful by-products of the disinfection process, regulating arsenic in ground water, evaluating the risk posed by exposure to mixtures of contaminants, and confronting the threat of terrorist attacks on water supplies. Offered online, annually. Prerequisite: 420.604 Hydrology and Water Resources, equivalent course, or experience.
Prerequisite(s): Must satisfy prerequisite course (AS.420.604) prior to enrolling in AS.420.629

AS.420.630. Tropical Ecology and Conservation of African Wildlife. 4 Credits.
This is an immersive study abroad field course in Cameroon, Africa with a strong focus in tropical ecology field methods for the purpose of conserving African wildlife. The Congo Basin is the second largest tropical rainforest in the world, storing an estimated 25-30 million tons of carbon stocks, and home to nearly 20% of Earth's species. There is a critical need to better understand the Congo Basin's rainforests because we cannot conserve what we do not understand. The field component of this course takes place at the Dja Nature Reserve in southeast Cameroon at a remote research station operated by the Congo Basin Institute. The Dja rainforest is a diverse and understudied ecosystem. This course will cover basic field methods including but not limited to biodiversity assessments, species population estimates, setting up and checking large mammal camera traps, auditory surveys of primate vocalizations, mist netting for tropical birds, and other field techniques. Couse content will focus on problems such as ecological impacts of biodiversity loss, drivers of wildlife poaching, conservation strategies and best practices. Students will be introduced to local leaders in conservation, members of the community from the ecosystems we'll be working in, as well as indigenous residents from the Baka tribal group. This course will also explore the broader social, political, economic, and climate change impacts to wildlife conservation efforts in Africa. Prerequisite: AS.420.611 – Principles and Methods of Ecology.

AS.420.631. Field Methods in Stream & Water Quality Assessment. 3 Credits.
This course provides an overview of field methods used to sample and assess various biological, physical, and chemical components in streams, rivers, and lakes. It allows students to determine the impact human activity has on aquatic environments. Students gain hands-on experience with standard sampling techniques, and with the detection, identification, and quantification of biological specimens and chemical pollutants in the aquatic environment. Students discuss water quality standards and federal regulations such as the Clean Water Act and Safe Drinking Water Act. Also included are study design, gear selection, sample preservation, and safety. Basic approaches to analyze and report findings are covered, with emphasis on methods currently practiced by government resource agencies. Offered onsite every two years. Prerequisite: 420.611 Principles and Methods of Ecology, equivalent course, or experience.

AS.420.632. Air Quality Management and Policy. 3 Credits.
Understanding and mitigating air pollution, both indoor and outdoor, is of extreme importance to global health. In fact, the World Health Organization released a statement in 2014 that in 2012, approximately 7 million people died - one in eight of total global deaths around the world - as a result of air pollution exposure. Air pollution also has an impact on climate change, in terms of its abilities to both exacerbate and reduce global warming. This course provides an overview of the principles, effects, and policies regarding outdoor air pollution with an emphasis on emerging international air pollution issues, public health and environmental impacts of outdoor air pollution, and evolving ways to monitor air pollution, from low-cost sensors to satellite techniques. Course topics include: history of air pollution events and management; major air pollutants and sources; atmospheric chemistry, transport and dispersion; measurement and monitoring; control technology; effects on human health and climate; and regulatory requirements. The effectiveness of the Clean Air Act, approaches toward air quality management in other countries, international treaties, future air quality projections, and regulatory case studies will also be discussed. Offered online, infrequently. Prerequisite: 420.608 Oceanic and Atmospheric Processes, an equivalent course or experience, or approval of the instructor.
Prerequisite(s): Must satisfy prerequiste course (AS.420.608) prior to enrolling in AS.420.632

AS.420.634. Bioremediation & Emerging Environmental Technologies. 3 Credits.
This course presents details of environmental technologies for assessment and remediation of contaminated sites. The course includes a brief review of environmental policy related to impacts of hazardous chemicals and endocrine blockers, but focuses on remediation technologies available for reclaiming contaminated resources and reducing health risks. It covers the application of multiple physical and chemical technologies, but emphasizes use of biological systems for the cleanup of hazardous chemicals. In the course, students are introduced to the nature of hazardous waste, behavior of chemicals in the subsurface, biochemistry of microbial degradation and technology applications. Bioremediation technologies covered include bioventing, air sparging, monitored natural attenuation or intrinsic remediation, and chemical oxidation. Students learn to select appropriate technologies, design a monitoring program for assessing the applicability of bioremediation techniques, develop biological conceptual models for natural attenuation, and understand the key principles for design. Case studies and problem sets acquaint students with field applications and introduce modeling techniques for predicting performance. Offered onsite, infrequently. Prerequisites: 420.601 Geological Foundations of Environmental Science and 420.604 Hydrology and Water Resources, equivalent courses, or experience.

AS.420.635. Integrated Water Resources Management. 3 Credits.
Integrated water resources management provides coordinated, goal-oriented control for development of river, lake, ocean, wetland and other water assets. This course provides students with a broad introduction to U.S., EU and international perspectives. The evolution of basic concepts behind IWRM will be explored as well the limits of current practices and strategies. Students will examine several different conceptual frameworks, and become familiar with how various US water management agencies and international institutions such as the World Bank, USAID, UNDP and the EU apply the principles of IWRM in various settings. Associated concepts of river basin management, climate adaptation and sustainable development will be addressed within the context of IWRM. Case studies will be presented and evaluated by the students.

AS.420.637. Conservation Biology and Wildlife Management. 3 Credits.
In this course students examine the meaning and implications of biodiversity with a focus on disciplines associated with conservation biology, wildlife conservation and wildlife management, including taxonomy, genetics, small population biology, chemical and restoration ecology, and marine biology. This includes exploring how conservation biology differs from other natural sciences in theory and in application. Students learn the major threats to biodiversity and what natural and social science methods and alternatives are used to mitigate, stop, or reverse these threats. The course also includes the economic and cultural tradeoffs associated with each conservation measure at the global, national, regional, and local levels. The course is taught in the seminar-style with field trips. Offered in person in Baltimore, Washington DC or off-site annually. Prerequisite: 420.611 Principles and Methods of Ecology, equivalent course, or experience.

AS.420.638. Coastal Zone Processes and Policy. 3 Credits.
The course is designed to provide the student with knowledge to address modern coastal, environmental, geologic, and policy issues. The course will focus on the coasts, barrier-islands, major estuaries, and inner continental shelf areas of the United States. Fundamental coastal engineering principles will be described in order to address methods used for public works projects including hurricane protection, beach nourishment, and tidal inlet maintenance. The policies pertinent to management and use of coastal environments will be studied. Offered online every other year. Prerequisite: 420.601 Geological Foundations for Environmental Sciences, equivalent course, or experience.

AS.420.639. Landscape Ecology. 3 Credits.
Landscape ecology is a rapidly developing area of study that explicitly examines the effects of spatial pattern and scale on ecological processes that unfold over areas of several square kilometers or larger. Thus, landscape ecology provides many concepts, tools, and approaches that will enhance the effectiveness of endeavors such as watershed management, ecosystem management, design of conservation reserves and green infrastructure, and smart growth. The goal of this course is to give students a firm grasp of the concepts of landscape ecology and of how they can be applied to enhance the effectiveness of environmental policy, management, regulation, and assessment. Offered online at least every other year. Prerequisite: 420.611 Principles and Methods of Ecology, equivalent course, or experience.
Prerequisite(s): Must satisfy prerequisite course (AS.420.611) prior to enrolling in AS.420.639

AS.420.641. Natural Resources Law and Policy. 3 Credits.
This course introduces students to federal and state legislation and policies of critical importance in natural resource management. Students explore such issues as regulation of ocean fishing, coastal zone management, mineral exploitation and associated environmental impact, water allocation and quality, hazardous waste cleanup programs under the Superfund law, urban industrial infrastructure such as water and sewage systems, land use management, and water and air pollution control. Offered onsite of online every two years. Completing 420.614 Environmental Policymaking and Policy Analysis is recommended. An equivalent course or experience may also suffice.

AS.420.642. Public Lands-Private Interests:The Struggle for Common Ground. 3 Credits.
This course prepares students to participate in the great debate over the use and protection of America 's federally owned forests, rangeland, parks, and sanctuaries. Students consider such questions as how much should be paid for grazing on federal lands; how to balance the demand for timber harvest with the need for watershed and wildlife management; who controls mineral and oil extraction on federal lands; and who has the rights to waters flowing through federal lands and stored behind federally funded dams. These and similar issues of today and tomorrow are studied in the context of history, statute and case law, and administrative regulations. Offered infrequently.Prerequisite: 420.614 Environmental Policymaking and Policy Analysis, equivalent course, or experience.

AS.420.643. U.S. Environmental History. 3 Credits.
Environmentalism is a multifaceted phenomenon infused with many different schools of thought about the nature of environmental problems as well as the most appropriate solutions for those problems. This course will examine the major historical influences on the varied approaches to environmentalism and environmental practice. Students will explore the influence of environmental ideas and actions in the US from the 19th century to the present. The goal is to deepen our understanding of contemporary environmental practice – by others and ourselves – by tracing the influence of these historical trends in current debates and actions. Topics include conservationism, preservationism, transcendentalism and green romanticism, toxic construct, the wilderness construct, and sustainability.

AS.420.644. Sustainable Cities. 3 Credits.
This course examines urbanization and its impacts on the environment. The goal of the course is to better understand how urbanization contributes to ecological damage as well as how cities can be constructed in ecologically healthy ways. Topics include land use planning transportation, waste, management, water quality, open space/greening, green building technology, urban design, and urban ecology. The course takes an international perspective by using case studies of cities in North America, Europe, Asia, Latin America, and Africa. The case studies also include a wide range of cities with different populations, geographic scale, and growth rates. Final projects are an in-depth study of one particular city of the student's choice and its attempts to implement programs for sustainability. Offered online, annually. Prerequisite: 420.614 Environmental Policymaking and Policy Analysis, equivalent course, or experience.

AS.420.646. Transportation Policy and Smart Growth. 3 Credits.
This course examines how transportation policy and decisions can alleviate or prevent problems resulting from urban sprawl. How can transportation decisions and planning contribute to more livable urban design and land use patterns that promote smart growth that is environmentally and ecologically sustainable? Students discuss how different environmental media land, water, and air are affected by our transportation systems and resulting development patterns, and how the design of transportation systems the highways, roads, transit systems, and bike and walk paths can more closely harmonize with nature and provide communities with a better quality of life. A wide range of policy options is examined, from altering the structure of road pricing to redesigning neighborhoods and altering urban form. A number of case studies are examined to illuminate the issues and principles raised in the course. Offered online at least every other year. Prerequisite: 420.614 Environmental Policymaking and Policy Analysis, equivalent course, or experience.

AS.420.650. International Environmental Policy. 3 Credits.
This course explores the methods and strategies for promoting solutions to global environmental problems. Through consideration of issues such as stratospheric ozone depletion, global climate change, tropical deforestation, loss of biodiversity, transnational pollution, and other threats to the international commons, students examine policymaking from the perspective of developed and developing countries, the United Nations system, international financial entities, and nongovernmental interest groups. By investigating important international agreements, students determine how far the international community has come in solving specific problems, what obstacles prevent effective international solutions, and what needs to be done to overcome barriers. Offered onsite or online, infrequently. Prerequisite: 420.614 Environmental Policymaking and Policy Analysis, equivalent course, or experience.
Prerequisite(s): Must satisfy the prerequisite course (AS.420.614) prior to enrolling in AS.420.614

AS.420.651. Environmental Risk in Decision Making. 3 Credits.
Analysis of risk is one of the most powerful tools and components of regulatory decision making. Based on the premise that risk assessment has no "right' answers, this course explores what risk perception, risk management, and risk communication mean. Students are introduced to terminology and concepts necessary in risk communication. Case studies help to explain the complexities of risk assessment and management. Students learn how to balance the costs and benefits of risk reduction and how to account for the uncertainties in risk estimates. Prerequisite: 420.614 Environmental Policymaking and Policy Analysis, equivalent course, or experience.

AS.420.652. Environmental Justice. 3 Credits.
The field of environmental justice is riven with conflicts over the scope, measurement, evaluation, nature and seriousness of environmental problems. This course takes a seminar approach to develop options for resolving environmental justice problems using both practical and theoretical approaches for communication, understanding and analysis to bridge interests, reconcile differences, reduce confusions and improve environmental decision making. The course will investigate and evaluate the effectiveness and possibilities of policies that can highlight, educate and develop understanding among communities concerned with environmental issues. The course will focus on how communication can encourage discussion about potential causes and responses to environmental justice concerns. A primary area of the course will be to examine how disenfranchised groups understand environmental justice within a hierarchy of community concerns, accumulated experience and particular histories within communities. The course has an applied aspect and will look at a local manifestation of how environmental justice is inseparable from broader components of justice such as living and working conditions, violence, powerlessness, marginalization, and processes producing and reproducing inequities. Offered online, annually. Prerequisite: 420.614 Environmental Policymaking and Policy Analysis, equivalent course, or experience.

AS.420.654. Environmental & Natural Resource Economics. 3 Credits.
This course presents the fundamental concepts and applications of economic theory related to environmental protection and the management of natural resources, including renewable resources (i.e., fisheries) and exhaustible resources (i.e., petroleum). Topics covered include sustainability, the relationship between the environment and the economy as a whole, the role of government in addressing market failures, how economic incentives can be used to protect the environment, concepts and methods for valuing environmental benefits and cost-benefit analysis of environmental regulatory policies. Prerequisite: AS.420.614 - Environmental Policymaking and Policy Analysis, equivalent course, or experience.
Prerequisite(s): Must satisfy prerequisite course (AS.420.614) prior to enrolling in AS.420.654

AS.420.656. Environmental Impact Assessment & Decision Methods. 3 Credits.
This course introduces the process of environmental impact assessment and policy decision making as required under the National Environmental Policy Act (NEPA) and the regulations of the Council of Environmental Quality (CEQ). Topics include identification of purpose and need for any actions affecting the environment, development of objectives and decision criteria, and various techniques for assessing impact and comparing alternatives for a given environmental intervention. The strengths and weaknesses of various approaches are evaluated with techniques that allow analysis of multiple objectives and conflicting uses of environmental resources. The importance of scientific credibility and public acceptance is demonstrated with actual cases. Offered onsite or online annually.Prerequisite: 420.614 Environmental Policymaking and Policy Analysis, equivalent course, or experience.

AS.420.659. Management for Environmental Results with Performance-based Measurement. 3 Credits.
At all levels of government and throughout private industry, performance-based initiatives now place unprecedented demands on environmental managers to achieve measurable environmental results. The goal of the various performance based initiatives is to give environmental managers a systematic understanding of the causes of environmental problems, both natural and anthropogenic, and their human, ecological and economic effects. It is also at the heart of sound environmental impact analysis, risk assessment, and benefit-cost analysis. In this course, students learn the foundations and applications of modern performance-based initiatives. Using case studies taken from a variety of environmental programs, students learn to use available scientific knowledge to uncover the likely keys to program success. Students learn why success has so often eluded environmental managers in the past. The goal of this class is for students to critically assess the design, performance measurement and management of environmental programs on all scales and to recommend effective improvements. Students will develop skills for implementing results oriented environmental management. Offered onsite or online, annually.

AS.420.660. Strategies in Watershed Management. 3 Credits.
Watersheds are often thought of as the basic organizing units for landscapes and the natural resources they support. As water is a fundamental resource that shapes landscapes, nourishes life, provides habitat and recreation, and transports sediments, nutrients, and wastes, prudent management of watersheds is critical for thriving ecosystems and human populations. The course comprises ten on-line modules students, each with topical content, web pages to visit, readings in the required text, and a quiz. Most modules also have discussions, and some have other assignments. The final discussion is a brief essay on a relevant topic of the student's choice. Students are introduced to definitions of 'watershed' and 'watershed management' in the context of natural resources science and policy. There is a brief review of basic hydrology, a look at the history of watershed management, and examination of the institutions and legislation that control activities affect watershed management. We discuss threats to watershed health, sources of information to guide watershed managers, and practices that can ameliorate the threats. Through case histories, the students are exposed to the collaborative process for assessing, protecting, and restoring watersheds. Offered online, annually.

AS.420.662. Coral Reefs and Caves: The Geology of the Bahamas. 3 Credits.
This course presents an opportunity to study the physical, chemical and biological processes that operate to produce carbonate platforms (e.g. tides, waves and the growth of corals), geomorphic processes that operate to further shape carbonate platforms (e.g. ground-water flow, cave development and soil development), and the environmental impacts of human activities on carbonate platforms. The course consists of two weeks of intensive, online study followed by a week of field study at the Forfar Field Station on Andros Island in the Bahamas. Offered only as a compressed field course every other January Intersession. Prerequisite: 420.601 Geological Foundations for Environmental Science.

AS.420.665. Climate Change on the Front Lines: The Study of Adaptation in Developing Countries. 3 Credits.
Poor and developing countries are predicted to bear the brunt of climate change. This course will focus on key sectors such as agriculture, forestry, biodiversity, water resources, human health, and tourism and the ways in which poorer and developing counties are impacted by and adapting to climate change. This course may focus on a region or a specific country depending on the instructor. Assessment and evaluation of demographic trends, environmental challenges such as retreating ice, potential flood hazards, ecosystem impacts, as well as health issues will be incorporated. International instruments such as adaptation funds, carbon funds, clean development mechanisms, and reduced deforestation/degradation strategies and policies will be investigated in a comparative analysis of impacts and adaptation responses of countries around the world. Offered online, annually.

AS.420.666. Community Development and Sustainability in developing countries. 3 Credits.
This course introduces community development concepts via discussion of the environmental-social-economic nexus in developing countries. Students will seek answers to key questions such as: (a) How rural communities in developing countries interact with their natural environment (b) What are the drivers, tradeoffs, and feedback loops of such interactions and what lessons can be drawn to seek common ground for sustainability (c) how do interaction between social, environmental, and economic dimensions shape communities to adapt to changes in these dimensions (d) what are some of the successful models of sustainable community development and environmental management (e) what is the fundamental concept of sustainability and factors that influence sustainability and its pathways (f) what are some of the efforts in place through government, nonprofits, and the private sector to assist developing countries in attaining sustainability. Students will discuss topics ranging from energy saving stoves in the Himalayas; to indigenous practices in Africa for mitigating human-wildlife conflict within buffer zones; to community-driven approaches for water management and agriculture; to community forestry and leasehold forestry models. In addition to key problems and challenges, students will be introduced to important tools used to translate ideas into sustainable action, such as project logical frameworks. By the end of the course, students interested in international, community, and sustainable development would be able to engage in related debates and be familiar with approaches and techniques for designing sustainability solutions.

AS.420.667. Analysis of Environmental & Ecological Data. 3 Credits.
This course will teach participants how to develop work flows going from raw data to graphics and statistical analysis, using the programming language and statistical environment R. Topics will focus exclusively on the biological sciences and will cover foundational concepts in statistical modeling (ANOVA, Regression, ANCOVA, PCR, etc); emphasis is on conceptual underpinnings of statistics not methodology, with a focus on defining statistical models and the major inference paradigms in use today.

AS.420.668. Sustainable Food Systems. 3 Credits.
This course considers the environmental and social challenges of providing a sustainable global food system. We will investigate the geographic patterns of agricultural and food production systems, emphasizing contemporary patterns and how these came to be. Attention will be given to agricultural systems from the local to the global scale and we will consider the global distribution of production and consumption of agricultural products. The impacts of global change issues such as climate change, energy crops, population growth, and urbanization on food production will be also be part of the course. Offered online or onsite, annually.

AS.420.669. Applied Sustainability. 3 Credits.
This course examines the history and current trends in the expanding field of sustainability. Students will be exposed to a wide range of case studies, visit many field sites and have discussions with sustainability practitioners in Maryland to determine the current state of the science as well as impediments to progress. Additional work includes practical application through development and implementation of a sustainability-related vision project. Offered only as a compressed field course every other summer. Offered as intensive field course every other summer.

AS.420.670. Sustainability Leadership. 3 Credits.
Using a highly interactive format, this course examines practical, state-of-the-art concepts in leadership, with a focus on the unique challenges of sustainability facing our world. Students will examine the essential components of leadership, including vision, communication, strategy, organization, synergy and strategy. Recognition of barriers and risks and how to work around them will be stressed, and the restricted conditions under which leadership is actually exercised will be revealed. Students will also practice self-reflection/assessment and become familiar with advanced tools to improve their leadership ability. Coursework will include frequent work in small groups, review of leadership case studies and a practical, 'real-world' vision development project. Offered only as a compressed field course every other January intersession.

AS.420.671. Global Land Use Change. 3 Credits.
This course provides a comprehensive examination of global land use change including the current spatial and historical extent of forests and grasslands, methods used to detect forest cover and its current and historical changes. Reviewing these patterns will lead to an understanding of the past and present drivers of land use change. In this course, we will consider the hydrological, and major biogeochemical cycles (i.e., carbon, nitrogen and phosphorus) and the impacts that forests and grasslands (and the loss of these ecosystems) has had on these cycles. The impact of forest loss on biodiversity, long term functioning of ecosystems and climate will also be discussed. After reviewing the effects of a loss of these environmental processes, we will bridge the physical and biological sciences with the social sciences by examining economic impacts and socioeconomic drivers of deforestation. Lastly, current policies and the potential effect of policies that aim to reduce deforestation such as REDD will be discussed.

AS.420.672. Environmental Ethics. 3 Credits.
Environmental Ethics is a philosophical discipline that examines the moral relationship between humans and the natural environment. For individuals and societies, it can help structure our experience of nature, environmental problems, human-environmental relations, and ecological awareness. Beginning with a comprehensive analysis of their own values, students will explore complex ethical questions, philosophical paradigms and real-life case studies through readings, films and seminar discussions. Traditional ethical theories, including consequentialism, deontology, and virtue ethics will be examined and applied. Environmental moral worldviews, ranging from anthropocentric to ecocentric perspectives, will be critically evaluated. Organized debates will help students strengthen their ability to deconstruct and assess ethical arguments and to communicate viewpoints rooted in ethical principles. Students will apply ethical reasoning skills to an examination of contemporary environmental issues including, among others, biodiversity conservation, environmental justice, climate change, and overpopulation. Students will also develop, defend and apply their own personal environmental ethical framework. A basic understanding of modern environmental history and contemporary environmental issues is required. Prior experience with philosophy and ethics is not required.

AS.420.673. Ecology and Evolution of the Galapagos. 3 Credits.
The Galapagos Islands have often been called the laboratory of evolution, where scientists have been able to study in detail many of the processes that have shaped the face of life on our planet. There are few places in the world, where it is possible to find such a variety of species, both animal and plant, which show so many degrees of evolutionary change, in such a restricted area. This course will focus on the tectonic development of the Islands and of the origin, evolution, and ecology of flora and fauna, and the reasons for the concentration of threatened and endangered species in the forests and on the Galapagos Islands. In the marine environment, emphasis will be placed on the ecological processes that maintain biodiversity, community organization, and the impacts of climate change which are threatening such communities.

AS.420.674. Applied Energy Policy in the 21st Century. 3 Credits.
This course provides an overview of clean energy technology and deployment, infrastructure and finance for environmental scientists and policy makers. Topics include civics, climate science, renewable energy, energy efficiency, sustainable transportation, city infrastructure (energy, transportation, water), and public private partnerships. Emphasis is placed on a place-based approach to energy policy, including climate smart resilient cities and how new urban mobility can address social problems.

AS.420.675. Geology and Tropical Ecology of Hawai'i. 3 Credits.
The breathtaking beauty and unfettered access to the soaring Mauna Kea, the highest mountain when measured from the ocean floor, and home to the Big Island's eight major climate zones, from desert to alpine, inspire countless superlatives. The volcanoes of the Big Island of Hawai'i are one of the premier examples of active hotspot volcanism in the world, and are by far the most accessible. This location offers an un-paralleled opportunity to observe the planetary processes of destruction and creation through Hawai'i's geology and tropical ecology. This field course explores the unique marine, freshwater and terrestrial habitats of the island interconnections between the geology and the ecology and the integrated management of natural resources from volcanic mountain tops to the biodiversity of the coral reef. The primary goal of this interdisciplinary course will be to provide a solid foundation in field science for both geologic and ecologic methods. Specifically, we will examine the geological development of Hot Spot generated Hawaiian ocean islands we will describe the biological development of the ecosystems on the islands, and examine the interaction between humans (landscape use and introduction of exotic species) and the island environments (major biomes and anthropomorphic systems). As a field course natural communities will be a major emphasis. On land, focus will be placed on the tectonic development of the Islands and of the origin, evolution, and ecology of flora and fauna, and the reasons for the concentration of threatened and endangered species in Hawaii. In the marine environment, emphasis will be placed on the ecological processes that maintain biodiversity, community organization, and the impacts on coral reefs.

AS.420.676. Global Scarcity in Freshwater Systems: Crisis and Solutions. 3 Credits.
This graduate-level course explores the dual nature of water scarcity worldwide, including both natural and human causes, and what is being done to help people and ecosystems cope with scarcity. The course covers definitions of water scarcity, the geographic extent of the problem, and trends in factors that contribute to it. It also examines several types of actions that are being taken to deal constructively with water scarcity. These actions fall into the general categories of monitoring, supply enhancement, conservation, re-use, pollution control, lifestyle changes to lower our water footprint, and public policy changes. Many of these actions, especially those related to public policy, are incorporated into seven principles of sustainable water management detailed in the course textbook, "Chasing Water: A guide for moving from scarcity to sustainability", by Brian Richter of the Nature Conservancy. Examination of the principles helps to end the course on a hopeful note by reminding us that humans collectively use only 5-10 percent of the water that falls as precipitation, and we have the capacity to greatly reduce the human suffering and environmental damage caused by poorly managed use of freshwater resources.

AS.420.677. Spatial Statistics. 3 Credits.
Spatial Statistics is a rapidly developing tool in the discipline of ecology that analyzes both 2-D and 3-D data that contain a spatial component. Many ecologists use continuous data (e.g., vegetation density and height, net aboveground primary production, percent of biomass killed by disturbance, etc…) that violates the assumption of spatial independence; therefore, necessitating the need to analyze the data using spatial statistics. Thus, spatial statistics provides concepts, tools, and approaches that will enhance the analyses of population data, sample data, partitioning of regions (patch and boundary), spatial interpolation, and data that are spatially autocorrelated. The goal of this course is to give students a firm grasp of the concepts of spatial statistics in ecology and of how they can be applied to analyze continuous data for environmental policy, management, and assessment. Uses of case studies, data analysis in the R spatial statistics package, and discussions help to examine and apply the concepts.

AS.420.678. Nature Conservation and Sustainability in Cuba. 3 Credits.
This cultural and scientific emersion program will investigate Cuba's agroecology, tropical marine and terrestrial ecosystems as well as the countries unique geology. As wildlife and habitat have faded from the tropics, Cuba's importance as an ecological bastion has risen. The island has the largest tracts of untouched rain forest, unspoiled reefs and intact wetlands in the Caribbean islands. Cuba also is home to many unique, or endemic, species, including the solenodon, and the bee hummingbird, the world's smallest bird. In this course, students will have the opportunity to learn about the marine ecology through first-hand investigation of the reefs off the shores of Cuba, and learn about rainforest ecology through observations of Cuban forests. The course will also examine the interplay between geology, ecology, evolution and adaptation in areas such as coastal xeromorphic vegetation, swamp ecosystems, and Viñales National Park.

AS.420.679. International Water: Issues and Policies. 3 Credits.
This course is a broad survey of the international water issues facing the 21st century. Topics to be covered include, water security, privatization of water service delivery, conflict and cooperation on trans-boundary rivers, the role of large multi-purpose reservoirs (for hydropower, water supply, irrigation), water as a human right, achieving the Sustainable Development Goals on water supply and sanitation, the role of water in food security, water institutions and policies, and climate change. Any discourse today on sustainable development is not complete without a discussion of the important role of water to society, economic growth, and poverty reduction. Our objective in this course is to gain a broad overview of these issues, primarily from the sustainable development lens, and to critically evaluate these challenges from a multi-disciplinary perspective (e.g. economics, environment, social, engineering, public health). This is important as solutions to water problems will require many different disciplines and expertise working together.

AS.420.681. Climate Change Adaptation and Development in Nepal. 3 Credits.
This is a field course that takes a firsthand look at the reality of climate change adaptation at various scales as it is experienced in in a developing country such as Nepal. Specifically it considers Nepal's vulnerability and resilience to climate change at the national, district and community levels, and will review adaptation instruments and actions at all levels and the political context in which they are executed. Specific topics to be covered include climate change by sector, vulnerability at various scales, institutional and community-based plans for mitigation and adaptation, institutional and legal mechanisms that address climate change, extension efforts, climate change integration into development, and current effort by developing countries such as Nepal in carbon-financing and other topics. The course will also consider how funding to support climate change adaptation intersects and overlaps with development aid and planning. The course will start and end in Kathmandu, the capital city, where students will meet with policy makers, government officials and experts. We will also travel to communities in the three biophysical regions of Nepal, the highlands, the middle hills and the lowlands (Terai). In all locales students will interact with stakeholders all various kinds and be exposed to the great cultural, economic, political, and biophysical diversity of Nepal.Course prerequisite: 420.665.81, Climate Change on the Front Lines: The Study of Adaptation in Developing Countries, or permission of the instructor.

AS.420.687. Science Communication and Policy Engagement. 3 Credits.
This course provides students with an introduction to the theory and practice of communicating science and engaging with different types of audiences including policymakers, the public, and the media. Science is valued by many and sharing our understanding of science and technology is a crucial part of engaging beyond the scientific community. In this course, we will explore current research on the science of science communication, as well as how to create narratives for engagement based on the goals and audience. Students will have the opportunity to discuss engagement strategies and communication methods, design an engagement plan, and practice using their skills for engaging with policymakers, public audiences, the media, and more.

AS.420.690. Environmental Health. 3 Credits.
The environment plays an important role affecting public health. This course will explore major topics in the area of environmental health, examining sources, routes, and health outcomes associated with exposure to microbial, chemical and physical agents in the environment. This course will cover how such agents affect human disease at the individual, community, and population level. Students will also explore how environmental health challenges are addressed through development of policy in a regulatory framework.

AS.420.703. Open Source GIScience for Environmental Research. 3 Credits.
This course on Free and Open Source GIS is targeted at students who already have some experience working with ArcGIS and want to learn about alternative software packages. The course will discuss the advantages and disadvantages? of open source GIS in contrast with more commercial GIS offerings. Geographic Information Science is now embedded in just about everything we do. From Google Maps to geotagging to wearable technology. Depending on your career choice, commercial software may not always be available for use or affordable. However, there are free, Open Source GIS software options available and as these tools become more powerful, more employers are adding knowledge of these software packages as required or desired skills. In this course, students will use free, publicly available environmental geographic data to perform GIS and remote sensing tasks using Open Source Software (e.g. QGIS, Remap, EO Browser). Students will learn how to obtain, create, analyze, assess, generate, and visualize environmental data relevant to environmental science fields like habitat assessment, natural disturbances, conservation, and landscape ecology.

AS.420.704. Practical Engineering Approaches to Climate Adaptation. 3 Credits.
 This course will briefly examine what risks recent POLICY actions pose to the environmental, economic and social infrastructure of the US and global community – especially the less developed nations – from the standpoint of climate-related natural disasters [floods, droughts, tsunamis, landslides, hurricanes, typhoons, monsoons, storm surges, forest fires, etc], and what technologies and technical options can be enlisted to mitigate the adverse [and some positive] effects associated with global warming. <o:p></o:p> This course will focus on a few technical mitigation [e.g. geo-engineering] options, but will focus mainly on practical adaptation options and strategies related to contemporary [and future innovative] infrastructure solutions and existing 'best management practices' for coastal erosion, storm preparedness, flood/drought management and preservation of ecological systems. Real case studies, based on recent disasters, such as Hurricane Katrina [New Orleans] and Superstorm Sandy [New York metropolitan region], as well as international examples from the Great Lakes, Columbia R. basin, Rio Grande basin, Mekong River basin, small island states, and both European and African case studies will be used to highlight each of the major engineering-based adaptation strategies. <o:p></o:p>

AS.420.705. Natural Resources Sustainability: Field Study in Alaska. 3 Credits.
This interdisciplinary field-based course examines the natural, cultural history and resource management in the ecosystems of Southeast Alaska. Through class lecture/discussion and field excursions, students obtain an understanding of integrated resource management and sustainability in protected areas while assessing options for addressing impacts and perturbations in habitats where species have and continue to be affected. The course will emphasize a variety of disciplines including: marine science and fisheries, wildlife management, geology, energy resources, forestry, botany, eco-tourism and anthropomorphic impacts to biodiversity, marine and wilderness areas.

AS.420.738. Newfoundland and Labrador: A Journey Through Time. 3 Credits.
The field course will examine the origins of the North American Continent and the Appalachians including the creation and destruction of oceans, human ecology, climate change, tectonics, whaling, and marine fisheries around the Labrador Sea and the Grand Banks. Field locations include four UNESCO World Heritage sites: <o:p></o:p> <ul style='list-style-type:disc'>
Gros Morne National Park, featuring majestic fjords and glacial valleys; L'Anse aux Meadows, North America's first authenticated Viking settlement; Red Bay, the 16th-century Labrador home to over 1,500 Basque whalers; and
Mistaken Point Ecological Reserve, site representing the oldest multicellular life on Earth.

AS.420.800. Independent Research Project in Environmental Sciences and Policy. 3 Credits.
The independent research project enables students to apply and synthesize the material learned in their courses, develop expertise on a specific environmental topic, work closely with an expert in the field, and improve their professional writing skills. Students who take this elective must identify a project topic and a Mentor who is both familiar with the chosen topic and willing to guide and oversee the project. The Mentor may be a faculty member teaching in the program or elsewhere at JHU, a qualified and appropriate person from the student's place of work, or any expert with appropriate credentials. A preliminary proposal must be approved by the Mentor and the Course Instructor prior to enrollment in the course. In order to enroll in the class, permission of instructor is required. Final proposals for the IRP must be approved by the Mentor and the Course Instructor at least two weeks prior to the start of the semester in which the IRP is to be completed. A Mentor Agreement form must be completed and returned at the beginning of the semester in which the student in take the I.R.P. course. This form is sent to the Mentor by the Course Instructor once the final proposal is approved. For more information please go to the ESP website => The Experience => IRP. Offered every term and scheduled as needed.

AS.420.801. Independent Study. 3 Credits.

AS.420.805. Internship and Capstone Thesis. 3 Credits.
This course is designed to allow students to have a Capstone/Thesis Internship Experience, a Group Research Project as well as the standard Capstone (Independent Research Project) in an internship format. Advanced students in the MS in Environmental Science and Policy program may propose an internship to receive on-the-job experience in science or science policy or a related profession. An approved internship receives one full course credit toward the MS in ESP degree usually an elective. Students may propose to participate in existing internship programs, or they may arrange a unique experience. In most cases, students should have completed four or more courses toward their degree before seeking an internship, and proposals must be submitted in writing to program leadership at least 30 days before the start of the target term. Proposals are evaluated on a competitive basis. Only a limited number will be approved, and priority will be given to students who have completed the most degree-level courses and who submit proposals that demonstrate the best internship experience. Internships may be paid or unpaid. To complete the course, students must write a robust paper designed for peer-review. The adviser for the paper will be the faculty member teaching the course in conjunction with a mentor as part of the internship experience. Because students receive academic course credit for internships, they pay tuition levels equal to one graduate course.

AS.420.888. Capstone or Thesis Continuation.
Noncredit. This course is for students who completed 420.801 Independent Research Project or 420.805 Internship and Thesis but failed to finish an approved paper or thesis. Required for those who have completed all of their coursework and have taken the above course but have not yet completed their paper. Students must register for this course and pay its accompanying fee for every term until a final paper is approved.