

## **UNDERGRADUATE COURSES**

### **POLICY, PLANNING, AND MANAGEMENT RELATED COURSES**

#### **AAEC 3324: ENVIRONMENT AND SUSTAINABLE DEVELOPMENT ECONOMICS**

Economics of environment and sustainable development. Topics include economic efficiency, property rights, externalities, benefit-cost analysis, economic evaluation procedures, public and private conflicts in land use, water quality, and international growth/development/ environmental issues. Pre: AAEC 1005 or ECON 2005. (3H,3C)

#### **AAEC 3314: ENVIRONMENTAL LAW**

Principles of law involved in environmental issues, survey of environmental litigation, legislation and administrative rulings. Law topics include natural resources, water pollution, private land use, air pollution, toxic substance, food, drug, pesticides, and biotechnology. (3H,3C) II.

#### **ALS/NR 4614: WATERSHED ASSESSMENT, MANAGEMENT, AND POLICY**

Multidisciplinary perspectives of assessment, management and policy issues for protecting and improving watershed ecosystems. Topics include: monitoring and modeling approaches for assessment, risk-based watershed assessment geographic information systems for watershed analysis, decision support systems and computerized decision tools for watershed management, policy alternatives for watershed protection, urban watersheds, and current issues in watershed management. Pre: Two 4000 level courses in environmental/natural resource science, management, engineering, and/or policy in BSE, CEE, FOR, GEOL, LAR, CSES, ENT, BIO, GEOG, AAEC, UAP or equivalent. (2H, 2C). II.

#### **CEE 4344: WATER RESOURCES PLANNING**

Analysis of the water resources planning process and the institutional framework for water resources management. Criteria and procedures for evaluating management alternatives are examined, with emphasis on assessment of economic and environmental impacts. Senior standing required. (3H,3C)

#### **GEOG/NR 2004: INTRODUCTION TO WATER RESOURCES AND ENVIRONMENTAL ISSUES**

Introduction to the hydrologic cycle, water resources, and related environmental issues. Emphasis on relationships between human needs for and effects upon water including; factors influencing water quality, droughts, and floods; water for health, energy, and food; water laws, allocation, and conflict; water resources and climate change; and potential solutions for these and other critical water issues. Pre: Sophomore-level standing. (3H,3C)

#### **LAR 3154: WATERSHED SENSITIVE DESIGN & CONSTRUCTION**

Examines soil and water resource issues related to landscape architectural site planning and design. Key topics include watershed sensitive site design, estimation and management of storm water runoff, rainwater conservation, design of open channel conveyances for site planning applications, and erosion and sedimentation control. Pre: LAR 2164 or consent of instructor. (4C)

#### **UAP 3354: INTRODUCTION TO ENVIRONMENTAL POLICY AND PLANNING**

Introduction to the interdisciplinary principles of environmental policy, planning, economics, and ethics to address pollution abatement, resources conservation, habitat protection, and environmental restoration. The course will focus on practical means of identifying environmental problems and creatively solving them. (3H,3C)

#### **UAP 4374: LAND USE AND ENVIRONMENT: PLANNING AND POLICY**

Environmental factors involved in land use planning and development, including topography, soils, geologic hazards, flooding and stormwater management, ecological features, and visual quality. Techniques used in conducting environmental land inventories and land suitability analyses. Policies and programs to protect environmental quality in land use planning and development. Pre: Junior standing. (3H,3C)

#### **UAP 4344: LAW OF CRITICAL ENVIRONMENTAL AREAS**

This course examines the legal principles and policy debates involved in the regulation and protection of critical environmental resources. Specific topics vary but will likely include wetlands law and policy, endangered species habitat, open space, forestland and farmland protection, coastal zone management, and floodplain regulation and policy. (3H,3C)

### **WATER SCIENCE RELATED COURSES**

#### **BIOL 4004: FRESHWATER ECOLOGY**

Interactions of physical, chemical, and biological properties of freshwater ecosystems. Senior standing required. Pre: BIOL 2804. (3H,3L,4C) I,II.

#### **BIOL/ENT 4354: AQUATIC ENTOMOLOGY**

Biology and taxonomy of insects and other macroinvertebrates most commonly encountered in freshwater environments. Selected aspects of biology, such as habitat, feeding, locomotion, and life history. Identification of individual taxa, mostly at family and genus level. Significance of these organisms in aquatic ecology, pollution monitoring, and natural resource management. Pre: (BIOL 1005, 1006), (BIOL 1015, 1016) or (BIOL 1105, 1106, 1115, 1116). (3H,3L,4C)

#### **BIOL/ENT/FIW 4484: FRESHWATER BIOMONITORING**

Concepts and practices of using macroinvertebrates and fish to monitor the environmental health of freshwater ecosystems. Effects of different types of pollution and environmental stress on assemblages of organisms and underlying ecological principles. Role of biological studies in environmental regulation. Study

design, field and laboratory methods, data analysis and interpretation, verbal and written presentation of results. Pre: (BIOL 2804), (BIOL 4004 or 4354 or ENT 4354 or FIW 4424 or FIW 4614). (3H,3L,4C)

#### **BSE 4224: FIELD METHODS IN HYDROLOGY**

Site characterization: surveying, channel and floodplain mapping, land use, electronic data acquisition. Techniques for measuring surface and subsurface hydrologic processes: water flow, hydrologic conductivity, precipitation, evaporation. Sampling techniques: surface water, groundwater, and soil pore water sampling. In-situ monitoring: automatic samplers, data loggers, water quality. Laboratory analyses: good laboratory practices, selection of analytical method, calibration, quality assurance/quality control. Co: BSE 3324 or CEE 3314 or FOR 4354. (2H,3L,3C)

#### **BSE 3334: NONPOINT SOURCE POLLUTION ASSESSMENT AND CONTROL**

Erosion prediction and control; transport and fate of sediment, nutrients, and microorganisms; design of nutrient management plans, wetlands, detention facilities and other management practices for rural and urban nonpoint source pollution control. Pre: BSE 2004, BSE 3324, CSES 3114. (2H,3L,3C)

#### **BSE 4324: NONPOINT SOURCE POLLUTION**

Engineering aspects of the sources and magnitudes of nonpoint source pollution, major causative factors, and control techniques. Emphasis on hydrologic factors, erosion, atmospheric deposition, adsorption and degradation of pollutants in soil, disposal of agricultural wastes, and management for the control of urban and agricultural nonpoint source pollution. Pre: CEE 3104. (3H,3C)

#### **BSE 4304: NONPOINT SOURCE POLLUTION MODELING AND MANAGEMENT**

Concepts, principles and application of modeling and monitoring for assessment and management of nonpoint source pollution. Design and implementation of monitoring systems. Concepts of modeling agroecosystems and land use impacts on hydrologic/water quality response of upland catchments. Model selection, calibration, validation, and application for comparative analysis. Screening models using Geographic Information Systems. Case studies in current watershed management issues, with a focus on agricultural waste and nutrient management, using existing field and watershed models. Pre: BSE 3334. (2H,3L,3C)

#### **BSE 3324: SMALL WATERSHED HYDROLOGY**

Precipitation, soil physics, infiltration, evapotranspiration, groundwater hydrology, overland flow, open channel flow, flow routing, hydraulic analysis. Co: CEE 3304 or CHE 3114 or ESM 3015 or ESM 3024 or ME 3404. (3H,3C)

#### **BSE 2384: SOIL AND WATER RESOURCES MANAGEMENT**

Fundamental principles involved in the management of soil and water resources are presented. Emphasis is placed on the planning and management of irrigation systems and the control of soil erosion on agricultural lands. Non-engineering students. Pre: (MATH 1016 or MATH 1025). (3H,3C). I.

#### BSE 4394: WATER SUPPLY AND SANITATION IN DEVELOPING COUNTRIES

Social, economic and engineering principles of water supply and sanitation in developing countries as affected by climate, cultural and sociological factors, and material and financial resources. Pre: CEE 3104. (3H,3C)

#### CEE 4354: ENVIRONMENTAL HYDROLOGY

Overall view of pollutants movements in surface waters, with emphasis on the role of various hydrologic processes. Natural and constructed wetlands and their use for water quality control. Fundamentals of river hydraulics. Design of flood control channels. Environmental consequences of various types of hydraulic systems. Mitigation, enhancement, and restoration techniques. A grade of C- or better required in prerequisites CEE 3104 and CEE 3314. Pre: CEE 3104, CEE 3314. (3H,3C)

#### CEE 3304: FLUID MECHANICS FOR CIVIL AND ENVIRONMENTAL ENGINEERING

Hydrostatics; fluid motion; continuity, momentum, and energy equations; viscous effects; applications to pipe networks and hydraulic systems, including open channel flow. Laboratory experiments and demonstrations. A grade of C- or better in pre-requisite ESM 2104. Pre: ESM 2104. (3H,2L,3C)

#### CEE 4314: GROUNDWATER RESOURCES

Fundamentals of groundwater hydrology; flow through porous media, both saturated and unsaturated; flow to wells in both confined and unconfined aquifers; seepage of groundwater to canals and field drains; analysis of aquifer test data to quantify flow and storage parameters; contaminants in groundwater, basic introduction to groundwater modeling. A grade of C- or better required in prerequisite CEE 3304. Pre: CEE 3304. (3H,3C)

#### CEE 4304: HYDROLOGY

Precipitation, evaporation, consumptive use, infiltration; stream flow, flood routing; statistical analysis of hydrologic data, flood and drought forecasting, risk analysis, subsurface flow, well hydraulics, introduction to urban drainage design. A grade of C- or better required in prerequisite. Pre: CEE 3304. (3H,3C)

#### CEE 4334: HYDRAULIC STRUCTURES

Hydraulic analysis and design of engineering structures for water control, including reservoirs, dams, spillways, spilling basins, drainage structures, and hydraulic models. A grade of C- or better required in prerequisite CEE 3314. Pre: CEE 3314. (3H,3C)

#### CEE 3104: INTRODUCTION TO ENVIRONMENTAL ENGINEERING

Overall view of environmental engineering with emphasis on hazardous waste management, water treatment, wastewater treatment, air pollution and its control, solid waste management, groundwater pollution and environmental regulations. A grade of C- or better required in pre-requisites. Pre: (CHEM 1035 or CHEM 1074), (CHEM 1045 or CHEM 1084), (MATH 1206 or MATH 1206H or MATH 1226 or MATH 2016 or MATH 2024), (PHYS 2305 or PHYS 2205). (3H,3C)

#### CEE 4324: OPEN CHANNEL FLOW

Mechanics of open channel flow, including uniform flow, gradually varied flow, channel transitions, and unsteady flow. Pre: CEE 3314. (3H,3C)

#### CEE 4104: WATER AND WASTEWATER TREATMENT DESIGN

Design of municipal water and wastewater treatment plants. Emphasis on characterization of water and wastewater and physical, chemical, and biological treatment methods. Sludge processing advanced treatment methods and treatment plant hydraulics are considered. A grade of C- or better required in prerequisites. Pre: CEE 3104, CEE 3304. (3H,3C)

#### CEE 3314: WATER RESOURCES ENGINEERING

Open channel flow; hydrology; hydraulic modeling; hydraulic machinery and structures; laboratory experiments and demonstrations. A grade of C- or better required in prerequisite CEE 3304. Pre: CEE 3304. (3H,2L,3C)

#### CSES 3634 (ENSC 3634): PHYSICS OF POLLUTION

Physical processes that control the fate of pollutants in our land, air, and water resources. Types and sources of pollutants, physical processes in the soil-water-atmosphere continuum controlling the dispersion and deposition of pollutants, the movement of pollutants, including radionuclides, by surface and subsurface water flow in soils, and physics of disturbed soils. Pre: CSES 3114, PHYS 2205, (MATH 2016 or MATH 2024). (3H,3C). I.

#### CSES 4594: SOIL AND GROUNDWATER POLLUTION

Application of mathematical models for chemical movement in soils and groundwater to evaluate soil and groundwater pollutant behavior; discussion of pollution remediation technologies; design of subsurface monitoring networks; case studies in soil and groundwater pollution; applications to landfills, waste spills, septic drain fields, pesticide/fertilizer leaching, and other problems of environmental concern. Pre: (MATH 2224 or MATH 2204 or MATH 2204H), (GEOL 4114 or CEE 4314). (3H,3C) I,II.

#### CSES/ENSC 3614: SOIL PHYSICAL AND HYDROLOGICAL PROPERTIES

Soil physical and mechanical properties and the physical processes controlling soil water retention and flow in agronomic and natural settings. Grain size distribution, weight-volume relationships, specific surface, electrical charge density, consistency, stress, compaction, rainfall runoff, water retention, steady/non-steady water flow in saturated/unsaturated soil, infiltration, bare soil evaporation, and soil water balance. Pre: (CSES 3114, 3124) or (GEOS 3614, GEOS 3624). (3H,3C)

#### CSES/ENSC 4314: WATER QUALITY

Provide comprehensive information on the physical, chemical, biological, and anthropogenic factors affecting water quality, fate and transport of contaminants in water, water quality assessment and management, and current water quality policies. Pre: (ENSC 3604 or BIOL 4004), (MATH 2015 or MATH 1026), (BIOL 1105 or BIOL 1106), (CHEM 1035 or CHEM 1036). (3H,3C)

#### CSES/ENSC 4324: WATER QUALITY LABORATORY

Teach students a variety of laboratory chemical and biological techniques for water quality analysis. Complementary to CSES/ENSC 4314. Pre: CHEM 1046. Co CSES/ENSC 4314. (3L,1C)

#### CSES/ENSC 4854: WETLANDS SOILS AND MITIGATION

Wetland soils as components of natural landscapes: biogeochemistry, hydrology, geomorphology, hydric soil indicators, and wetlands functions under various land uses. Soil and hydrologic factors important to wetland delineation and jurisdictional determination. Mitigation of wetland impacts with emphasis on restoration and creation. Outdoor lectures at local wetlands and a two-day long field trip to observe and identify wetland soils are mandatory. Pre: (CSES 3114, CSES 3124) or (ENSC 3114, ENSC 3124) or (GEOS 3614, GEOS 3624) or CSES 3134 or ENSC 3134. (2H,3L,3C)

#### FIW 4534: ECOLOGY AND MANAGEMENT OF WETLAND SYSTEMS

Introduction to the variety of wetland systems found in North America, though emphasis will focus on eastern and mid-Atlantic wetland systems. Origin and processes of formation of wetlands, functions and values of wetlands, wetland delineation, wetland classification, regulatory processes affecting wetlands. Objectives of and management techniques used to protect and/or manipulate wetland systems for wildlife and other human needs. Enrollment restricted to junior, seniors and graduate students. Pre: BIOL 3204. (2H,3L,3C)

#### FIW 4614: FISH ECOLOGY

Interactions of fish with the physical and biological environment. Adaptations of organisms, populations, and communities. Impacts of human activities on major aquatic ecosystems and important fishes. Ecological principles for management of important sport, commercial, and prey fishes. Pre: BIOL 1006. (3H,3C) II.

#### FIW 4714: FISHERIES MANAGEMENT

History, theory, and practice of fisheries management. Emphasis on basic strategies used in effective management and setting management objectives. Synthesis of fish population dynamics and manipulation, habitat improvement, and human management to achieve objectives. Case studies of major fisheries. Pre: FIW 3514. (3H,3L,4C) II.

#### FIW 3514: FISHERIES TECHNIQUES

Application of field and laboratory methods in fisheries management and research. Experience with fisheries equipment and techniques. I. Pre: FIW 2114. (1H,6L,3C)

#### FIW 4424: ICHTHYOLOGY

Morphology and physiology, systematics, zoogeography, and identification of fishes. Pre: BIOL 2504 or BIOL 2704. (2H,6L,4C) II.

#### FIW 4624: MARINE ECOLOGY

Marine organism, biological, ecological, chemical and physical processes of marine ecosystems in open sea, coastal and benthic environments, research methods and models in marine ecosystem simulation; fisheries in a dynamic ecosystem: human interference and conservation. Pre: BIOL 2804 or GEOS 3034. (3H,3C)

#### FIW 2114: PRINCIPLES OF FISHERIES AND WILDLIFE MANAGEMENT

Basic principles guiding the management of fish and terrestrial animals in wild habitats. Management of organisms, habitats, and human users examined in terms of biological, chemical/physical, ecological, and sociological theories and practices. Worldwide illustration from both recreational and commercial resources. I. Pre: BIOL 1006 or BIOL 1106. (3H,3C)

#### FOR 4354: FOREST SOIL AND WATERSHED MANAGEMENT

Properties and processes of soil and water in forests. Emphasis on management for the delivery of ecosystem goods and services. Includes analysis and interpretation in field and laboratory. Pre: CSES 3114 or ENSC 3114 or GEOS 3614 or CSES 3134 or ENSC 3134. (2H,3L,3C)

#### FOR 4374: FORESTED WETLANDS

Classifications, jurisdictional delineation, and management options of forested wetlands. Relationship of hydrology, soils, and vegetation to ecosystem processes, societal values, and management with regard to environmental and legal considerations and best management practices. Emphasis is on forested wetlands in the southern U.S., but national and international wetlands are included. Pre: CSES 3114 or CSES 3134. (3H,3C) II.

#### FOR 3104: PRINCIPLES OF WATERSHED HYDROLOGY

Study of hydrology in watersheds. Qualitative and quantitative principles of physical hydrological processes governing the movement, storage, and transformation of water on the Earth's surface as influenced by watershed characteristics, including human modifications. Pre: Junior Standing Pre: (MATH 1206 or MATH 1226) or (MATH 2015 or MATH 1026). (3H,3C)

#### GEOS 4804: GROUNDWATER HYDROLOGY

Physical principles of groundwater flow, including application of analytical solutions to real-world problems. Well hydraulics. Geologic controls on groundwater flow. Pre: (GEOS 1014, PHYS 2205) or (PHYS 2305, MATH 1206). (2H,3L,3C)

### GEOS 3034: OCEANOGRAPHY

Descriptive and quantitative treatment of the geological, physical, chemical and biological processes that occur in, or are influenced by, the oceans. The history of oceanic exploration and discovery is addressed. Pre: (MATH 1206 or MATH 1226) or (MATH 2015 or MATH 1026). (3H,3C)