VT Water-Related Graduate Courses

BIOL 5074: STREAM ECOLOGY
Application of ecological principles to running water environments. Recitation: critical assessment of contemporary literature and research themes associated with stream ecosystems. Graduate standing required. Variable credit hours.

BIOL 6064: TOPICS IN FRESHWATER ECOLOGY
Readings and discussion in a specific area of freshwater ecology, including species interactions, and community level functions. Topics will vary, and course may be taken for credit more than once. Variable credit hours. Pre: BIOL 4004.

BSE 5214: ADVANCED TOPICS IN WATERSHED MANAGEMENT
An interdisciplinary exploration of advanced topics in watershed management. Reading, discussion, summary and presentation of current research in the areas of water quality and watershed management. Topics will be built around a semester theme that will vary by semester; the course may be repeated up to three times. Graduate standing required. (2H, 2C).

BSE 5224G – ADVANCED FIELD METHODS IN HYDROLOGY
Site characterization: surveying, channel and floodplain mapping, land use, electronic data acquisition. Techniques for measuring surface and subsurface hydrological 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 sondes. Laboratory analyses: GLP practices, selection of analytical method, calibration, QA/QC. Pre: Graduate standing. (2H, 3C).

BSE/CEE 5244: ADVANCED GIS IN HYDROLOGIC ANALYSIS
Advanced GIS course focusing on raster analysis with particular application to the issues associated with hydrologic analysis. Application and evaluation of algorithms for terrain analysis, watershed characterization, and hydrologic analysis and modeling as implemented in GIS. Digital evelation data sources and error assessment. Approaches to GIS/model integration and application. Pre: BSE 4344 or CEE 5204 or GEOG 4084 or BSE 3305 or CEE 4304. (2H, 3C).

BSE 5364: STREAM RESTORATION
Stream restoration practices related to channel dynamics, sediment transport, impact of human activities, aquatic habitat improvements, and design and assessment. Inspecting, classifying, identifying and measuring river features of channel morphology to predict river reaction to human activities and watershed change. Pre: Graduate standing. (2H, 3C).

BSE 5404: AGRICULTURAL NONPOINT SOURCE POLLUTION
Assessment and management of agricultural nonpoint source pollution (NPS). Precipitation, runoff, erosion, pollutant fate and transport, and best management practices. Application of Total Maximum Daily Loads and water quality standards. Pre: Background in physical, chemical, biological, and soil factors affecting the environment and in environmental regulations. (3H, 3C).

CEE 5100: STORMWATER TREATMENT
Stormwater quality. Basic traps, basins, and filters. Stormwater treatment. Basic vegetative control systems. Mechanistic role of wetland. Best management practices. Monitoring, sampling, analysis, and maintenance methods. Pre: Graduate standing.

CEE 5125 and 5126: ENVIRONMENTAL ENGINEERING DESIGN
5125: Design of wastewater treatment facilities for the reduction and elimination of organic and inorganic pollutants; 5126: Design of water treatment facilities for the production of potable waters from surface and groundwater systems.

CEE 5134: ENGINEERING ASPECTS OF WATER QUALITY
The application of biological, chemical, and physical principles of water quality to engineering problems in surface waters. Pre: CEE 3104. (3H, 3C).

CEE 5244 ADVANCED GIS IN HYDROLOGIC ANALYSIS
Advanced GIS course focusing on raster analysis with particular application to the issues associated with hydrologic analysis. Application and evaluation of algorithms for terrain analysis, watershed characterization, and hydrologic analysis and modeling as implemented in GIS. Digital elevation data sourses and error assessment. Approaches to GIS/model integration and application. Pre: Graduate standing.

CEE 5304: ENVIRONMENTAL FLUID MECHANICS
The first part of the course will be devoted to basic concepts and equations of fluid motion. The remainder of the course will be concerned with the theory of incompressible viscous and inviscid fluids. Selected applications will be drawn from environmental and water resources topics. Graduate standing required. (3H, 3C).

CEE 5314: RIVER MECHANICS AND SEDIMENT TRANSPORT
Sediment properties; critical stress; bed-form regimes in alluvial streams; depth-discharge relations for rivers; bed load and suspended load movement; river stability; flow in bends; river training. (3H, 3C).

CEE 5324: ADVANCED HYDROLOGY
Applications of statistics to hydrology, floods, and droughts; flow generation models; mathematical models in physical hydrology; difference methods in flow routing; kinematic wave; evapo-transpiration; infiltration; and atmospheric processes. (3H, 3C).

CEE 5334: ANALYSIS OF WATER RESOURCES SYSTEMS
Introduction to quantitative hydrology. Diverse computational aspects within watersheds. Methods and models used to examine components of hydrologic cycle. Risk analysis and statistical probability in hydrology. Comprehensive models for watershed management and urban hydrology. Pre: Graduate Standing.

CEE 5344: SURFACE WATER-GROUNDWATER INTERACTION
Interaction (exchange) of surface water with groundwater at watershed, reach, sediment-patch scales including bidirectional hyporheic flows. Focus on streams and rivers, consideration of lakes. Steady and unsteady exchange hydraulics including laminar and turbulent flows. Exchange benefits and engineering goals including heat transfer, nutrient processing, and contaminant attenuation. Engineering applications including conjuctive use of surface water and groundwater resources and impact of groundwater pumping on rivers. Field methods. (3H, 3C).

CEE 5354 (GEOS 5814): NUMERICAL MODELING OF GROUNDWATER
Theory and practice of numerical techniques are developed and applied to fluid flow and transport in ground-water flow systems. Governing equations are formulated using FD and FE techniques with appropriate BC's and IC's. Additional topics include: model conceptualization and grid design in multidimensional systems; practical applications of numerical models including calibration, validation, and prediction; concepts and techniques of advective transport using particle tracking and dispersive transport. Introduction to MODFLOW, MODPATH, MT3D, and others. (3H, 3C).

CEE 5364: WATER LAW
Analysis of law for allocation of surface and groundwater supplies, legal controls over water quality alteration, public rights of water use, and drainage law. Pre: Graduate standing. (3H, 3C).

CEE 5374: DYNAMICS GROUNDWATER
The theory of dynamics of fluids in porous media; fluid and matrix properties; transport equations; boundary and initial value problems; flow of immiscible fluids; dispersion. Pre: Graduate standing. (3H, 3C).

CEE 5384: TRANSPORT PROCESSES IN WATERWAYS
Advanced treatment of the mechanics of open channel flow, including uniform flow, gradually varied flow, channel transitions, and unsteady flow. Independent research project. Pre: Graduate standing. (3H, 3C).

CEE 5714: SURFACE WATER QUALITY MODELING
Use, analysis, and development of water quality models for lakes, rivers, and estuaries. Emphasis on model calibration, verification, and post-audit analysis. Lab portion will develop and apply an eutrophication model for an estuary using existing data. Variable credit hours.

CEE 5734: URBAN HYDROLOGY AND STORMWATER MANAGEMENT
Development of methods and numerical models for computing surface runoff from developing watersheds; hydraulics of combined sewer systems; urban non-point source pollutant load calculations and best-management practices; control strategies for regional stormwater management; detention basin design for control of urban floods and non-point source pollutants. Pre: Graduate standing. (3H, 3C).

CSES 5314: WATER QUALITY FOR PROFESSIONALS
Global water resource sustainability and management. Current water quality policies. Physical, chemical, biological, and anthropogenic factors affecting water quality, fate and transport of contaminants in water. Approaches of water quality risk assessment. Water treatment and management technologies. Pre: Graduate Standing. (3H, 3C).

CSES 5604: ENVIRONMENTAL SCIENCE CONCEPTS FOR PROFESSIONALS
Physical, chemical, and biological principles and processes that are central to human-environment interactions. Emphasizes air and water resources and the role of energy in human and natural systems. Major U.S. environmental legislation and regulations. Pre: Two semesters each of college chemistry and biology and one semester of economics. Graduate standing required.

CSES 5764G: ADVANCED BIOREMEDIATION
Environmental biotechnology and use of microbes and other organisms to remove contaminants and improve environmental quality. Treatment of contaminated soils, waters, and wastewaters; remediation of industrial waste streams. Current topics and future directions in biodegradation research. Pre: Graduate standing. (3H, 3C).

CSES 5854: ADVANCED WETLAND SOILS
Wetlands soils as components of natural landscapes: biogeochemistry, hydrology, geomorphology, hydric soil indicators, and wetland 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: Graduate standing. (3H, 4C).

CSES 5864: ADVANCED WETLAND SOILS AND MITIGATION
Wetland soils as components of natural landscapes and their interactions with hydrologic systems. Hydric soil identification and delineation, preparation of wetland water budgets, restoration of damaged wetlands, and creation of compensation wetlands. Utilization of advanced soil information systems and GIS/GPS in wetlands study. Constructed wetlands for nutrient removal and acid mine drainage treatment. Pre: CSES 5114 (UG) or CSES 5114. (3H, 3C).

FIW 5114: FISHERIES AND WILDLIFE CONSERVATION GENETICS
Population genetics of terrestrial and aquatic animals as applied to fisheries and wildlife management, endangered species management, and ecosystem protection. Discussion of genetic variability and analytic techniques, population genetic processes, and practical applications. (3H, 3C).

FIW 5464G: ADVANCED HUMAN DIMENSIONS OF FISHERIES AND WILDLIFE
Values, attitudes and opinions of people towards fish and wildlife. Social, economic, legal and political aspects of fisheries and wildlife management. Roles of professionals and the public in fish and wildlife policy processes. Contemporary fish and wildlife policy issues. Pre: Graduate Standing required. (3H, 3C).

FIW 5514: FISH POPULATION DYNAMICS AND MODELING
Theory and application of fish population models for managing recreational and commercial fisheries. Estimation of basic fish population statistics (abundance, mortality, growth). Development and application of models for age-structured populations, bioenergetics, growth, stock-recruitment, yield, predation, and competition. Pre: FIW 4714. Variable credit hours.

FIW 5534G: ADVANCED WETLAND ECOLOGY AND MANAGEMENT
Introduction to the variety of wetland systems found in North American, with emphasis 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. Objective of management and techniques used to protect and/or manipulate wetland systems for wildlife and other human needs. Graduate Standing required. Variable credit hours.

FIW 5624G: ADVANCED MARINE ECOLOGY
Marine organisms; biological, ecological, chemical and physical processes of marine ecosystems in open-sea, coastal, and benthic environments; research methods and models in marine ecosystem stimulation; fisheries in a dynamic ecosystem; human interference and conservation. Graduate Standing required. (3H, 3C).

FIW 5714G: ADVANCED FISHERIES MANAGEMENT
History, theory, and practice of fisheries management. Emphasis on basic strategies used in effective management objectives. Synthesis of fish population dynamics and manipulation, habitat improvement, and human management to achieve objectives. Case studies of major fisheries. Pre: Graduate Standing required. (3H, 4C).

FIW 5814: STREAM HABITAT MANAGEMENT
Application of stream ecology, fish biology, hydrology, and hydraulics to the protection, restoration, and enhancement of stream habitats and fauna. Major emphasis on stream habitat evaluation, regulated stream flow, biotic, integrity, and watershed management. I. Pre: BIOL 4004. (3H, 3C).

FIW 6004: TOPICS: FISHERIES AND WILDLIFE
Readings and discussion in a specific area of fisheries and wildlife conservation. Topic will vary and course may be taken for credit more than once. Background in fisheries or wildlife required. Variable credit course. Graduate standing required. I, II. Variable credit hours.

FREC 5144 HILLSLOPE AND WATERSHED HYDROLOGY
Physical concepts of hydrological processes that affect age, origin, and flowpaths of water from hillslope to waterslope to watershed scales. Analysis of current and historical research methods. Hydrological science as an interdisciplinary topic. Pre: Graduate standing. (3H, 3C).

FREC 5334: PLANT WATER RELATIONS
Properties and status of water in the plant and thermodynamics in relation to water and solute movement; measuring water deficits and drought tolerance; and transpiration and stomatal action. Variable credit hours.

FREC 5354: SOIL SCIENCE AND BIOGEOCHEMISTRY
Foundations of soil science and biogeochemistry. Concepts in soil and landscape evolution; elemental cycling; soil-plant-microbe interactions; soil sampling and analysis; and relationships among physical, chemical, and biological properties and processes. Pre: Graduate standing. (3H, 3C).

FREC 5374G: ADVANCED 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. Data analysis, interpretations, and report for field trips are required for graduate credit. Graduate Standing required. (2H, 3C).

FREC 5784G: ADVANCED WETLAND HYDROLOGY AND BIOGEOCHEMISTRY
Water flows creating wetland hydrologic regime. Hydrologic controls on wetland processes. Linkages between hydrology and biogeochemical cycles. Carbon, nitrogen, phosphorus, and other element cycles within and across wetland boundaries. Field methods to assess hydrologic regime and biogeochemical cycles. Ecosystems services from hydrologic and biogeochemical processes. Applications of wetland hydrology and biogeochemistry in wetland restoration, delineation, and creation. Pre: Graduate Standing. (3H, 3C).

FST 5634G: ADVANCED EPIDEMIOLOGY OF FOOD AND WATERBORNE DISEASES
Overview of causes, transmission, and epidemiology of major environmental, food, and waterborne diseases. Outbreak and sporadic detection, source tracking, and control of pathogens. Overview of the impact of food-borne outbreaks on regulatory activities at the national and international level. Pre: Graduate Standing required. (4H, 4C).

GEOG/GEOS 5134G: INTERDISCIPLINARY ISSUES AND ETHICS IN WATER RESOURCES
Analysis of issues and ethics related to water resources, water as a hazard upon human (infrastructure, economy) and ecological (rivers, groundwater) systems, water and vector borne disease, climate change, dams, and eutrophication. Development of proficiency in demonstrating the multidimensionality of water resources. Pre: Graduate Standing. (3H, 3C).

GEOS 5804: QUANTITATIVE HYDROGEOLOGY
Rigorous mathematical and physical concepts of fluid flow in porous geological media. The course will focus on the mechanics of groundwater flow in one, two, and three spatial dimensions. Boundary conditions and analytical solutions to subsurface and vadose-zone flow problems will be explored and solved analytically. The mechanics of horizontal and vertical deformation of aquifers due to applied pumping stress will be taught from first principles. Includes problems dealing with steady and transient groundwater flow, Biot's equations and three-dimensional consolidation theory. (3H, 3C).

GEOS 5804G: ADVANCED GROUNDWATER HYDROLOGY
Physical principles of groundwater flow, including application of analytical solutions to real-world problems. Well hydraulics. Geologic controls on groundwater flow. Graduate standing required. Variable credit hours.

GEOS 5814 (CEE 5354): NUMERICAL MODELING OF GROUNDWATER
Theory and practice of numerical techniques are developed and applied to fluid flow and transport in ground-water flow systems. Governing equations are formulated using FD and FE techniques with appropriate BC's and IC's. Additional topics include: model conceptualization and grid design in multidimensional systems; practical applications of numerical models including calibration, validation, and prediction; concepts and techniques of advective transport using particle tracking and dispersive transport. Introduction to MODFLOW, MODPATH, MT3D, and others. (3H, 3C).

GEOS 5834: CHEMICAL HYDROGEOLOGY
Study of solute transport in geologic systems. Focus on processes of advection, dispersion, mineral dissolution and precipitation, chemical reactions and microbially-mediated reactions. Includes use of hydrogeochemical models to simulate chemical transport in geologic systems. Graduate standing required. (3H, 3C).

NR 5384: WETLAND ECOLOGY AND POLICY
Examination of the relationship of hydrology, soils, and vegetation to wetland ecosystem processes and the value of wetland functions. Evaluate wetland definitions and classification. Explore decisions toward protecting, restoring, impacting and mitigating wetlands. Assess federal, state and local regulations for wetlands. Graduate standing required. (3H, 3C).

UAP 5064G: ADVANCED POLLUTION CONTROL PLANNING AND POLICY
Planning and policy aspects of managing residuals and environmental contaminants and their effects on human health and environmental quality. Technical and economic factors involved in management of water quality, air quality and solid and hazardous wastes, toxic substances, and noise. Implementation of pollution control legislation, policies, and programs at federal, state and local levels. (3H, 3C).

UAP 5134G: ADVANCED 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 for conducting environmental land inventories and land use suitability analyses. Policies and programs to protect environmental quality in land use planning. Prerequisite: Graduate standing required. (3H, 3C).

UAP 5214: TOPICS IN NATURAL RESOURCES AND NATURAL HAZARDS PLANNING
Concepts, theory, and practice of resilience-based, climate-change integrated natural resources management and hazards planning. Effects of land, water, soil, and ecosystem management on quality of life for present and future generations. Natural resources and natural hazards planning process and tools for local communities and policies at state and federal levels. May be repeated for a maximum of 9 credit hours. Pre: Graduate Standing. (3H, 3C)

UAP 5414: NATURAL RESOURCES PLANNING TOPICS
The natural resource planning process as implemented by federal public lands and water resources agencies in the U.S. Public participation, environmental impact assessment, and resource evaluation methods used in planning and decision-making. Applications to resources planning in developing countries. May be repeated with different topics for a maximum of 9 credits. Graduate standing required. Variable credit hours.

WATR 5614G: ADVANCED WATERSHED ASSESSMENT, MANAGEMENT, AND POLICY
Multidisciplinary perspectives of assessment, management, and policy issues for protecting and improving watersheds 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: Graduate standing. (2H, 2C).