March 26, 2020

ADDENDUM TO: REQUEST FOR AUTHORIZATION TO IMPLEMENT A DEGREE BACHELOR OF SCIENCE IN FRESHWATER SCIENCES AT UNIVERSITY OF WISCONSIN (UW)-MILWAUKEE

Student Learning Outcomes and Program Objectives

In the School of Freshwaters Sciences, the undergraduate program will emphasize the unique opportunities for hands-on learning through intensive laboratory and field experiences that span the interdisciplinary breadth of freshwater studies and scientific inquiry. As such, we are requiring all students in the program to complete and defend an undergraduate thesis or capstone project to support the development of critical thinking, problem solving, and research capabilities through independent research. Our curriculum is designed around the following competencies for the next generation of freshwater scientists:

PROGRAM OBJECTIVES

- Discovery—the requisite knowledge to understand the nature of these problems, which requires basic biology, chemistry, physics, geoscience, and mathematics. These basics provide the foundation for more advanced competencies in specific focus areas of freshwater systems where complex interactions drive the dynamics of the entire hydrologic cycle (streams, lakes, groundwater and atmosphere).
- Analysis/Assessment—the ability to identify, analyze, and anticipate problems, then develop solutions in the context of the multidimensional implications in the policy, economic, and social/cultural setting.
- Design—the integrative ability to devise solutions to complex problems and challenges using a suite of solutions informed by ecology, socio-politics, and technology in an integrative, holistic framework.
- Technology—the proficient use of the latest technology for data collection and analysis, and the ability to match the sophistication of the technology with the problem at hand.
- Communication—the ability to effectively convey written, oral, and visual concepts, data, and arguments to diverse strata of audiences; and develop skills in two-way communication with experts, stakeholders, and the community.

LEARNING OUTCOMES

1. Demonstrate understanding of the complexities of life in water, the interactions with the physical surroundings and the ecological relationships between organisms and their environment. (Discovery, Communication)
2. Understand the nexus between biological, ecological, physical, climate and economic systems as they relate to water. (Discovery, Analysis/Assessment)
3. Understand the hydrologic cycle and the processes and interactions among atmospheric, surface and ground water components and the issues and processes related to the quality of these waters. (Discovery, Analysis/Assessment, Design)
4. Demonstrate understanding of the chemical and biogeochemical interactions of both natural and anthropogenic substances and their importance within global earth system dynamics, natural freshwater resources, and water/wastewater management systems. (Discovery, Analysis/Assessment, Design, Technology, Communication)
5. Develop the skills to collect, analyze, interpret and communicate data and findings at multiple scales and across disciplines. This may include the ability to apply geographic information systems, systems modeling, environmental sampling, and genomics. (Discovery, Analysis/Assessment, Design, Technology, Communication)

6. Develop the computer literacy and skills to apply big data to environmental problems. Implement models as analytical and forecasting tools. (Analysis/Assessment, Design, Technology)
7. Understand the application of monitoring and smart sensor systems in creating built and natural environmental intelligence to enhance systems management. (Discovery, Analysis/Assessment, Design, Technology)
8. Understand the application of environmental laws, regulatory and management frameworks; and the economics of water resource use and allocation. (Analysis/Assessment, Design, Technology)

DESCRIPTION OF PROPOSED NEW COURSES

COURSE NAME
FRSHWTR 101 Elements of Water

PROGRAMMATIC LEARNING OUTCOMES ADDRESSED
1. Demonstrate understanding of the complexities of life in water, the interactions with the physical surroundings and the ecological relationships between organisms and their environment. (Discovery, Communication)
2. Understand the nexus between biological, ecological, physical, climate and economic systems as they relate to water. (Discovery, Analysis/Assessment)
3. Understand the hydrologic cycle and the processes and interactions among atmospheric, surface and ground water components and the issues and processes related to the quality of these waters. (Discovery, Analysis/Assessment, Design)
8. Understand the application of environmental laws, regulatory and management frameworks; and the economics of water resource use and allocation. (Analysis/Assessment, Design, Technology)

CREDITS 3

DESCRIPTION
This course is an introduction to water as it relates to humanity and its interaction with the environment. The physics, chemistry, and biota of freshwater combine to produce an ecological infrastructure that provides ecosystem services that all humans rely on. Socially relevant issues and the exploration of human dimensions of water use will be covered in this class. This course provides a foundation sufficient for a citizen to understand contemporary issues as well as preparation for advanced courses.

COURSE NAME
FRSHWTR 120: Preparing for a Career in Freshwater Sciences

PROGRAMMATIC LEARNING OUTCOMES ADDRESSED
Setting students on the course to meet all learning outcomes.

CREDITS 1

DESCRIPTION
This course will introduce students to the skill sets they will need for a successful career. In addition to competency in your field, employers seek skills in communication, teamwork, interpersonal relationships, administration, and leadership. Other important skills include networking capability, taking initiative, fostering mentorship, and maintenance of work-life balance.

Course Objectives:

Develop a better understanding of their career aspirations;
Create an individual development plan (IDP) which can be expanded throughout their degree program
Understand job markets and workplace culture;
Learn to communicate in professional settings both orally and via written material;
Possible Textbook:
"What Color is Your Parachute?" by Richard N. Bolles or
"Now What? The Young Person's Guide to Choosing the Perfect Career" by Nicholas Lore

COURSE NAME
FRSHWTR 201 The Water Environment

PROGRAMMATIC LEARNING OUTCOMES ADDRESSED

3. Understand the hydrologic cycle and the processes and interactions among atmospheric, surface and ground water components and the issues and processes related to the quality of these waters. (Discovery, Analysis/Assessment, Design)
4. Demonstrate understanding of the chemical and biogeochemical interactions of both natural and anthropogenic substances and their importance within global earth system dynamics, natural freshwater resources, and water/wastewater management systems. (Discovery, Analysis/Assessment, Design, Technology, Communication)

CREDITS 3

DESCRIPTION

1	The Hydrologic cycle - global view - reservoirs, residence times, rates of transport
	The atmosphere, river, lake, ocean continuum, weathering & why the ocean is salty and lakes vary
2	Properties of water I: physics of gas, liquid, ice; density, weight & pressure, buoyancy
	Properties of water I (cont.) - viscosity, diffusion, evaporation
3	Properties of water II: optics & light attenuation, sound in water -
	Properties of water II: Boundary layers - turbulence, diffusion, air-water, sediment-water, thermoclines, fish gills, etc.
4	Properties of water II: Boundary layers (cont.) -living at scales from um-km
	Dynamics of flow I: measuring velocity, waves and currents
5	Dynamics of flow I (cont.): waves and currents, basic equations
	Dynamics of flow II: flow in pipes and channels
6	Chemistry of water I: composition, solubility
	Chemistry of water II: chemistry of carbon & the global carbon cycle
7	Chemistry of water III: biogeochemistry, nutrients, stoichiometry of life, tracers
	Chemistry of water III (cont.): models
8	lab/field week
	lab/field week
9	midterm review
	midterm
10	The basics of changing Global water scarcity & security
	Dynamics of groundwater I
11	Dynamics of groundwater II
	Watershed Dynamics I: flow in rivers & streams
12	Watershed Dynamics II: Land use and runoff
	Water contamination - chemicals of concern
13	Water contamination - biological

	Drinking water & the built hydro-cycle
14	Stormwater systems, green and grey infrastructure
	Water quality, standards and treatment - what is clean? What is legal?
15	lab/field week
	lab/field week
16	review
	final

COURSE NAME
FRSHWTR 202 Life in Water

PROGRAMMATIC LEARNING OUTCOMES ADDRESSED

1. Demonstrate understanding of the complexities of life in water, the interactions with the physical surroundings and the ecological relationships between organisms and their environment. (Discovery, Communication)

CREDITS 4

DESCRIPTION

"Life in Water" is the study of how organisms adapt to diverse physical, chemical, and interspecies interactions in water. The approach focuses on convergent and divergent aspects of evolution so that the perspective of biological diversity surveys diverse adaptive solutions to challenges rather than principles of taxonomic classification.

This course is intended to complement FRSHWTR 2XX The Water Environment by emphasizing how organisms live in and adapt to the water environment, and what it means for human dependence on water for life. The course provides a number of field exercises examining a variety of the biotic aspects of water systems, both natural and built.

These exercises will survey and provide opportunities to examine the wide variety of organisms that live in freshwater systems (rivers, lakes, beaches, bio-reactors, etc.) the habitats they occupy, and how species interact with each other and their environment. Included will be examinations of adaptations, behavior, ecology, and a discussion of local and global resource management and conservation issues.

Habitats:

- Large lakes – physical forcing at scale, the biological oceanography of inland seas
- Rivers & streams: life in a flowing environment
- Harbors and estuaries
- Ponds and lagoons
- Built systems, bioreactors, aquaculture and aquaponics

Behavior:

- reproducing, growing and thriving in a changing fluid environment
- interferences driven by human impacts

Ecology

- dynamics of food webs and exploited populations (fisheries), examples of how complex parts assemble into ecosystems

Conservation & Restoration of ecosystems:

- Reconstructing sustainable ecosystems
- Problems of diversity
- Human use and misuse

Field exercises:

- Why beaches are sometimes open and sometimes closed
- Non-indigenous species invasions - How "natural" biota and ecosystems can become dominated by non-native species
- How do we treat drinking water and wastewater?
- Life in a flowing stream
- Intro to water-dependent industries (e.g. brewing, food processing, biofuels)

COURSE NAME

FRSHWTR 392 Water-Energy-Food-Climate

PROGRAMMATIC LEARNING OUTCOMES ADDRESSED

2. Understand the nexus between biological, ecological, physical, climate and economic systems as they relate to water. (Discovery, Analysis/Assessment)

6. Develop the computer literacy and skills to apply big data to environmental problems. Implement models as analytical and forecasting tools. (Analysis/Assessment, Design, Technology)

CREDITS 3

DESCRIPTION

Water, food, energy, and climate are central to issues of economic growth, social wellbeing, and environmental sustainability. This course introduces the main features and linkages in these complex interrelated systems. It integrates insights from biological, physical, and social sciences to build the analytic frameworks needed to conceptualize key system drivers and cross-scale relationships, and for assessing emerging challenges and potential policy options.

Part I. The climate system

1. The physics of climate, greenhouse gases and paleoclimate change
2. How do we observe climate change & weather?
3. The global carbon budget and terrestrial-ocean-atmosphere interactions, Modeling climate, uncertainties, and future projections¸ ocean acidification, sea level rise
4. Energy and climate, peak oil & fossil fuels, hydropower

Part II. The Global ecological system

1. Ecosystem energetics – energy flow, primary production
2. Basic biogeochemistry of food production - Peak phosphorus, the green revolution, pesticides
3. Population increase and urbanization – food security, how many people can the planet feed?
4. Economic changes, standards of living, moving up (or down) the food chain

Part III. Water, food, energy and climate

1. Freshwater systems and climate change - changing hydrology of the Great Lakes
2. Water scarcity and stress – causes, trends, water policy, pricing, property rights
3. Water, food, energy production and distribution
    a. Agricultural economics – food, biofuels, etc., changing agri-food systems, Farm scale operational models
    b. Aquaculture and fisheries
    c. Transportation of food, energy and water
    d. Environmental and health issues arising from food and energy production
    e. Interaction between food, energy, water markets

Part IV. Technology and policy

1. Climate policy: The Paris Climate Accords, the IPCC,
2. US Farm policies

3. Urban water systems, water supply & treatment, pricing
4. Mitigation, adaptation, carbon sequestration
5. Water management, conservation, alternative energy, desalinization
6. Market failures and their potential solutions (e.g., externalities, public goods)
7. Tools for evaluating policy (cost benefit analysis, cost effectiveness analysis, multi-criteria analysis, life cycle assessment)
8. Case studies

COURSE NAME
FRSHWTR 393 Water Law, Policy, and the Environment

PROGRAMMATIC LEARNING OUTCOMES ADDRESSED
8. Understand the application of environmental laws, regulatory and management frameworks; and the economics of water resource use and allocation. (Analysis/Assessment, Design, Technology)

CREDITS 3

DESCRIPTION
Statutory law, case law, and administrative practices relating to regulation of the water and environment resources including clean water act, environmental impact statements, pollution, public lands, and preservation law.
Potential Text: Vig and Kraft, 2018, Environmental Policy or Durant and Fiorino. 2017 .Environmental Governance Reconsidered: Challenges, Choices and Opportunities.

Understanding of institutions and regulatory framework for water and the environment in WI and federal government
Understanding of main water law doctrines adopted by US states
Understanding of the Great Lakes Compact
Understanding of Waters of the United States
Understanding of Agricultural Environmental Support programs such as CRP, WHIP, FSA and federal oversight
Understanding of Clean Water Act, NEPA, Clean Air Act and their synergies
Familiarize students with the history of the environmental movement
Familiarize student with the public policy process related to water laws, politics, and policy

COURSE NAME FRSHWTR 391 Water and Natural Resource Economics	
PROGRAMMATIC LEARNING OUTCOMES ADDRESSED 8. Understand the application of environmental laws, regulatory and management frameworks; and the economics of water resource use and allocation. (Analysis/Assessment, Design, Technology)	
CREDITS	3
DESCRIPTION This course provides an introduction to water and natural resource economics. Using microeconomic theory and tools, a framework for analyzing environmental management decisions is developed and applied to water and other natural resources. Topics include the efficient allocation of resources, market failures, rights of ownership, non-market valuation, and the institutions that impact management opportunities. **Potential Text:** Hacket and Dissanayake, Environmental and Natural Resources Application of supply and demand to water Understanding of market and non-market values for water Understanding and theoretical application of effects of market failure on water and natural resource quantity, quality, and protection Understanding of institutions and market tool effects on resource use Understanding of basic regulatory institutions and laws for water and natural resources at state and federal levels Introductory understanding of economic decision tools including pareto optimality and cost-benefit analysis	

COURSE NAME FRSHWTR 361 Intro to Environmental Data Systems	
PROGRAMMATIC LEARNING OUTCOMES ADDRESSED 6. Develop the computer literacy and skills to apply big data to environmental problems. Implement models as analytical and forecasting tools. (Analysis/Assessment, Design, Technology) 7. Understand the application of monitoring and smart sensor systems in creating built and natural environmental intelligence to enhance systems management. (Discovery, Analysis/Assessment, Design, Technology)	
CREDITS	3
DESCRIPTION This course provides an introduction to how data systems are integrated and applied in freshwater sciences. Approaches to acquire, manage, and process data and use analysis outcomes to inform social-environmental problems will be discussed. **Learning Outcomes:** Understand and apply the data science lifecycle Provide examples of opportunities and challenges in applying data systems to freshwater sciences Describe database technologies and identify their strengths and weaknesses Identify, access, and query databases containing information on freshwater systems Assess the validity and quality of data Understand key theoretical and statistical concepts to analyze complex data Use computer resources to apply big data to environmental problems Implement models as analytical and forecasting tools Explain best practices for data system management	

COURSE NAME
FRSHWTR 321 Exploration of Inland Seas

PROGRAMMATIC LEARNING OUTCOMES ADDRESSED
1. Demonstrate understanding of the complexities of life in water, the interactions with the physical surroundings and the ecological relationships between organisms and their environment. (Discovery, Communication)
2. Understand the nexus between biological, ecological, physical, climate and economic systems as they relate to water. (Discovery, Analysis/Assessment)
3. Understand the hydrologic cycle and the processes and interactions among atmospheric, surface and ground water components and the issues and processes related to the quality of these waters. (Discovery, Analysis/Assessment, Design)
4. Demonstrate understanding of the chemical and biogeochemical interactions of both natural and anthropogenic substances and their importance within global earth system dynamics, natural freshwater resources, and water/wastewater management systems. (Discovery, Analysis/Assessment, Design, Technology, Communication)

CREDITS 3

DESCRIPTION
The worlds large lakes, which include the Laurentian Great Lakes, African Great Lakes, and Lake Baikal (Siberia), have hydrodynamic physical properties not found for common lakes. Some of these hydrodynamic properties are related to size and are found in marine systems, but, being freshwater, there are properties due to large size that are not found in marine systems. The challenges to large lakes biota are different from those for both common lakes and marine systems, so ecosystem dynamics have properties that make these ecosystems distinctively different from common lakes and marine systems, and from each other. Topics are considered from a historical perspective, focusing on how science, management and policy have responded to fishing pressure, changes in water quality, weather conditions, and invasive species.

COURSE NAME
FRSHWTR 362 Calculating Nature

PROGRAMMATIC LEARNING OUTCOMES ADDRESSED
6. Develop the computer literacy and skills to apply big data to environmental problems. Implement models as analytical and forecasting tools. (Analysis/Assessment, Design, Technology)
7. Understand the application of monitoring and smart sensor systems in creating built and natural environmental intelligence to enhance systems management. (Discovery, Analysis/Assessment, Design, Technology)

CREDITS 3

DESCRIPTION
The study of any environmental resource or contaminant is ultimately concerned with three questions: How much is there? Where is it going? And, how long will it last? Answering these questions requires good environmental data and the math skills needed to turn raw numbers into inventories, fluxes, and residence times. This course will examine the fundamentals of quantitative environmental analysis, including dimensional analysis, approximation, visualization, and box modeling.

COURSE NAME
FRSHWTR 341 Sanitation and Sustainability

PROGRAMMATIC LEARNING OUTCOMES ADDRESSED

1. Demonstrate understanding of the complexities of life in water, the interactions with the physical surroundings and the ecological relationships between organisms and their environment. (Discovery, Communication)
4. Demonstrate understanding of the chemical and biogeochemical interactions of both natural and anthropogenic substances and their importance within global earth system dynamics, natural freshwater resources, and water/wastewater management systems. (Discovery, Analysis/Assessment, Design, Technology, Communication)

CREDITS 3

DESCRIPTION
Microbes are integral to the integrity of water and sustainable urban centers. Topic of exploration and discussion will highlight how microbes interface with health, ecosystems and society. The Seminar will be divided up into three parts. The first weeks, we'll focus on understanding microbes in general, and how they contribute to ecosystem processes and health, particularly in urban water systems. To cover these topics, we will use chalk talks and a book club format. Important concepts such as pathogen host relationships and water quality monitoring will be covered. The second portion of the course will explore important societal issues through directed readings. Cholera and Cryptosporidium outbreaks, dead zone formation in the Gulf of Mexico and Green Bay, and Legionella and Leptospira and the link to climate change are examples of case studies for discussion and writing assignments. The last part will consist of field trips and labs, and watershed exploration (i.e. EPA surf your watershed) to directly measure some of the microbes we learned about. We will focus primarily on urban infrastructure (stormwater, wastewater, green infrastructure).

Learning Objectives:

Students will be able to recognize significant events in history shaped by infectious disease and the important contributions of renowned microbiologists

Students will understand the basic biology of microorganisms and in particular, pathogens that affect humans. Students will be able to cite examples of waterborne disease outbreaks and convey the environmental and manmade causes

Students will be able to describe different types of urban water infrastructure, how it works, types of failure, and be able to explain the long term costs and investments needed to maintain these systems to protect public health

Students will understand components of the urban water cycle, including natural and built aspects and gain hands on experience sampling urban water sites

Students will be able to describe different types of indicator bacteria used to assess water quality, and the most important attributes of an indicator organism

Students will be able to assess and interpret water quality data for rivers, beaches, and Lake Michigan and recognize causes of impairments to swimming and other recreational activities

Students will demonstrate proficiency in organizing and communicating observations, experimental findings, and interpretations through lab and field reports.

Students will demonstrate an understanding of ecosystem services offered by freshwater and explain the complex interconnected impacts urbanization has on freshwater systems

Students will be able to describe different types of green (and blue) infrastructure and explain the value of these systems to protecting water resources and enhancing the urban environment

COURSE NAME
FRSHWTR 322 Ecology and Evolution of Freshwater Organisms

PROGRAMMATIC LEARNING OUTCOMES ADDRESSED
1. Demonstrate understanding of the complexities of life in water, the interactions with the physical surroundings and the ecological relationships between organisms and their environment. (Discovery, Communication)

CREDITS 3

DESCRIPTION
This course describes the fundamental concepts of ecology and evolution in aquatic systems. Examples of population, community and ecosystem dynamics will be discussed in relationship to the physical environment. The course will discuss how populations of aquatic organisms change and evolve over time due to natural and human induced influences on aquatic systems.

Learning outcomes:

Explain ecological processes important for freshwater populations, communities and ecosystems

Describe human impacts on freshwater systems at the population, community and ecosystem level of measurement

Understand how ecological processes limit and contribute to population growth and how this is measured

Be able to describe adaptations of aquatic species that contribute to their success in the freshwater environment

Understand the concepts of biogeography and factors that impact conservation

Understand microevolution in aquatic organisms and how population genetics can change over time (mutation, natural selection, drift)

Understand quantitative genetics in freshwater organisms

Macroevolution of freshwater organisms (e.g. speciation over time)

COURSE NAME FRSHWTR 342 Water Pollution Solutions: Water Technology and Management	
PROGRAMMATIC LEARNING OUTCOMES ADDRESSED 1. Demonstrate understanding of the complexities of life in water, the interactions with the physical surroundings and the ecological relationships between organisms and their environment. (Discovery, Communication) 4. Demonstrate understanding of the chemical and biogeochemical interactions of both natural and anthropogenic substances and their importance within global earth system dynamics, natural freshwater resources, and water/wastewater management systems. (Discovery, Analysis/Assessment, Design, Technology, Communication)	
CREDITS	3
DESCRIPTION This course will provide an overview of the types of pollutants found in freshwater systems (surface and groundwater), their origin and movement. Various approaches to cleanup, water and wastewater treatment will also be discussed. **Learning outcomes:** Understand dominant urban versus agricultural pollution sources and pollutants Understanding the concepts of point-source and non-point source pollution Understand transport of the pollution into freshwater systems Understand the role of atmospheric deposition and cycling in contaminant exposures Understand dominant urban versus agricultural pollution sources and pollutants Understand concepts of transformation of pollutants Understand the mechanics of water treatment and wastewater treatment technologies Understand strategies for removal and prevention	

COURSE NAME FRSHWTR 471 Introduction to Sensing Networks	
PROGRAMMATIC LEARNING OUTCOMES ADDRESSED 5. Develop the skills to collect, analyze, interpret and communicate data and findings at multiple scales and across disciplines. This may include the ability to apply geographic information systems, systems modeling, environmental sampling, and genomics. (Discovery, Analysis/Assessment, Design, Technology, Communication) 6. Develop the computer literacy and skills to apply big data to environmental problems. Implement models as analytical and forecasting tools. (Analysis/Assessment, Design, Technology)	
CREDITS	3
DESCRIPTION This course focuses on understanding of the basic principles and applications of sensing networks and big data. Topics to be covered include the introduction to sensing networks, including in-situ sensors, remote sensing, sensor network and ground-truth, principles and applications of in-situ physical, optical, chemical, and biological sensors in freshwater systems, data uncertainty, and data collection, synthesis and interpretation. Students will apply skills in programing, data formatting, and statistics to deal with visualization, uncertainties, and data report. Students will learn skills to efficiently process, integrate, analyze and visualize sensed data in freshwater environments, to link collected data with hydrological/biogeochemical/environmental processes and climate and environmental changes over different time scales, and to reveal patterns, trends, and associations relating to human-environment interactions and interactions between ecosystem components.	

COURSE NAME
FRSHWTR 421 Molecular Level Tools to Understand Larger Scale Change

PROGRAMMATIC LEARNING OUTCOMES ADDRESSED

1. Demonstrate understanding of the complexities of life in water, the interactions with the physical surroundings and the ecological relationships between organisms and their environment. (Discovery, Communication)
2. Understand the nexus between biological, ecological, physical, climate and economic systems as they relate to water. (Discovery, Analysis/Assessment)
4. Demonstrate understanding of the chemical and biogeochemical interactions of both natural and anthropogenic substances and their importance within global earth system dynamics, natural freshwater resources, and water/wastewater management systems. (Discovery, Analysis/Assessment, Design, Technology, Communication)
5. Develop the skills to collect, analyze, interpret and communicate data and findings at multiple scales and across disciplines. This may include the ability to apply geographic information systems, systems modeling, environmental sampling, and genomics. (Discovery, Analysis/Assessment, Design, Technology, Communication)
7. Understand the application of monitoring and smart sensor systems in creating built and natural environmental intelligence to enhance systems management. (Discovery, Analysis/Assessment, Design, Technology)

CREDITS 3

DESCRIPTION
Scientists often use measurements of phenomena at very small scales and extrapolate to much larger scales, and vice versa. It is critical to make linkages between observations at different scales to understand systems and their complexity.

Topics will include:
Molecular scale indicators (strengths and weaknesses)
Small scale indicators (strengths and weaknesses)
Medium scale indicators (strengths and weaknesses)
Large scale indicators (strengths and weaknesses)
What is a system?
System principles and archetypes
Complex adaptive systems
Simulation and experimentation
Freshwater system influences: biological, chemical, geological, physical
Interactions between natural and anthropogenic systems
System scalability
Uncertainty

COURSE NAME
FRSHWTR 585 Applied Water Statistics and Data Manipulation

PROGRAMMATIC LEARNING OUTCOMES ADDRESSED
Develop the skills to collect, analyze, interpret and communicate data and findings at multiple scales. This may include the ability to apply geographic information systems, systems modeling, environmental sampling, and genomics. (Discovery, Analysis/Assessment, Design, Technology, Communication)

CREDITS 3

DESCRIPTION
This course offers introductory-level instruction on descriptive and inferential statistics. Students will engage with the theory and practical application of statistical concepts essential to scientific inquiry, including data distributions, correlation, random variables, confidence intervals, and hypothesis testing. Students will be exposed to real-world applications of statistics and taught to conduct analyses in the R software environment, with an emphasis on data pertaining to freshwater resources.

Learning Objectives:
Understanding of descriptive statistics, representation of information, and exploratory data analysis
Introductory understanding of experimental design
Understanding of probability theory, discrete and continuous random variables, and sampling distributions
Understanding of institutions and market tool effects on resource use
Understanding and application of hypothesis testing, one- and two-way ANOVA, simple linear regression analysis, and chi-square tests
Understanding of data management and analysis in the R software environment

COURSE NAME
FRSHWTR 661 Professional and Capstone Planning

PROGRAMMATIC LEARNING OUTCOMES ADDRESSED
5. Develop the skills to collect, analyze, interpret and communicate data and findings at multiple scales and across disciplines. This may include the ability to apply geographic information systems, systems modeling, environmental sampling, and genomics. (Discovery, Analysis/Assessment, Design, Technology, Communication)

CREDITS 1

DESCRIPTION
Description: Preparation to work and communicate with environmental professionals, agencies, or clients and develop a written proposal to solve an environmental application or problem. Leads into the Spring capstone, but will allow students to form groups along similar interests, plan any data sampling or background research and develop a proposal to conduct spring project as a team.

COURSE NAME
FRSHWTR 663 Thesis Research Planning and Proposal Development

PROGRAMMATIC LEARNING OUTCOMES ADDRESSED
5. Develop the skills to collect, analyze, interpret and communicate data and findings at multiple scales and across disciplines. This may include the ability to apply geographic information systems, systems modeling, environmental sampling, and genomics. (Discovery, Analysis/Assessment, Design, Technology, Communication)

CREDITS 1

DESCRIPTION
Description: Preparation for scientific research to be completed as part of the undergraduate thesis. This will include identifying a relevant problem, understanding appropriate approaches for data collection and analysis specific to this problem, and developing a written proposal to address this important freshwater issue. Will include review of experimental design principles including replication, randomization, and control. Leads into thesis research activities (generally in the Spring semester. Will allow students to learn as a group, as well as provide comments as part of peer review critiques during proposal development

COURSE NAME
FRSHWTR 660 Undergraduate Capstone

PROGRAMMATIC LEARNING OUTCOMES ADDRESSED
5. Develop the skills to collect, analyze, interpret and communicate data and findings at multiple scales and across disciplines. This may include the ability to apply geographic information systems, systems modeling, environmental sampling, and genomics. (Discovery, Analysis/Assessment, Design, Technology, Communication)

CREDITS 6

DESCRIPTION
The capstone project allows students to demonstrate mastery of both a specific topic and the relationship of this topic to the broader subject of Freshwater Sciences in collaboration with fellow students and professionals. The capstone project should develop analytic solutions and communicate them in both written and oral form to professionals. The capstone project serves to demonstrate and apply the multidisciplinary skills students have learned in the program.

COURSE NAME
FRSHWTR 662 Undergraduate Research and Thesis

PROGRAMMATIC LEARNING OUTCOMES ADDRESSED
5. Develop the skills to collect, analyze, interpret and communicate data and findings at multiple scales and across disciplines. This may include the ability to apply geographic information systems, systems modeling, environmental sampling, and genomics. (Discovery, Analysis/Assessment, Design, Technology, Communication)

CREDITS 6

DESCRIPTION
The thesis serves to allow a student to demonstrate mastery of both a specific topic or laboratory experiment skills in relationship to the broader subject of Freshwater Sciences. The thesis or capstone project should demonstrate the student's analytic and interpretive skills. The thesis should serve as a summative expression of a student’s ability to form, answer, and communication research on an aspect of freshwater science in depth or from a variety of disciplines.