ENVE F446  Biological Unit Processes  
3 Credits  
Offered Spring Even-numbered Years  
Theoretical and applied aspects of biological wastewater treatment, including waste-activated sludge processes, trickling filters, lagoons, sludge digestion and processing, nutrient removal, biology of polluted waters, state and federal regulations.  
Prerequisites: MATH F302.  
Recommended: CE F341.  
Stacked with ENVE F646.  
Lecture + Lab + Other: 3 + 0 + 0

ENVE F641  Aquatic Chemistry  
3 Credits  
Offered Fall Even-numbered Years  
Chemistry of aquatic systems, including the development of equilibrium and kinetic models to understanding the speciation, transformation and partitioning of inorganic chemical species in natural and engineered water systems. Emphasis is on the study of acid-base chemistry, complexation, precipitation-dissolution and reduction-oxidation reactions.  
Prerequisites: Graduate standing.  
Cross-listed with CHEM F605.  
Lecture + Lab + Other: 3 + 0 + 0

ENVE F642  Contaminant Hydrology  
3 Credits  
Offered Spring Odd-numbered Years  
Theoretical and applied aspects of the movement of contaminants through saturated and unsaturated soil.  
Recommended: CE F663 or equivalent; graduate standing; or permission of instructor.  
Lecture + Lab + Other: 3 + 0 + 0

ENVE F643  Air Pollution Management  
3 Credits  
Offered Spring  
Air pollution topics including the quantity and quality of atmospheric emissions and their effects on the human environment. Identification and location of sources, measurement of quality and conformance with standards. Legal considerations of Clean Air Act and Amendments and local regulations. Evaluation of stationary and moving sources. Meteorology and modeling requirements. Control mechanisms for gases and particulates.  
Prerequisites: CHEM F106X; graduate standing.  
Recommended: MATH F252X.  
Stacked with CE F443.  
Lecture + Lab + Other: 3 + 0 + 0

ENVE F644  Environmental Management and Permitting  
3 Credits  
Offered Spring Odd-numbered Years  
Topics of environmental impact statements, environmental law (local, state and federal), public involvement and environmental quality. Impact from projects of mining, highways, airports, pipelines, industrial development, water, wastewater and solid waste, and others–theoretical considerations and case studies.  
Recommended: Graduate standing or permission of instructor.  
Lecture + Lab + Other: 3 + 0 + 0

ENVE F645  Unit Processes: Chemical and Physical  
3 Credits  
Offered Fall Odd-numbered Years  
Theory and design of chemical and physical unit processes for water and wastewater. Sedimentation, coagulation, flocculation, filtration, ion exchange, adsorption/absorption, gas transfer and other special topics. Emphasis on Arctic applications and design.  
Recommended: MATH F252X; CHEM F106X or equivalent; graduate standing; or permission of instructor.  
Lecture + Lab + Other: 3 + 0 + 0

ENVE F646  Biological Unit Processes  
3 Credits  
Offered Spring Odd-numbered Years  
Theoretical and applied aspects of biological wastewater treatment, including waste-activated sludge processes, trickling filters, lagoons, sludge digestion and processing, nutrient removal, biology of polluted waters, state and federal regulations.  
Prerequisites: Recommended: Graduate standing.  
Stacked with ENVE F446.  
Lecture + Lab + Other: 3 + 0 + 0

ENVE F647  Biotechnology  
3 Credits  
Offered Fall Even-numbered Years  
Theoretical and applied aspects of bioengineering. Issues studied include microbiology, metabolism, genetics, genetic engineering, enzymes and catalysis, stoichiometry and kinetics, biological reactor design and bioremediation.  
Recommended: Graduate standing or permission of instructor.  
Lecture + Lab + Other: 3 + 0 + 0

ENVE F649  Hazardous and Toxic Waste Management  
3 Credits  
Offered Fall Odd-numbered Years  
The course provides in-depth coverage of hazardous and toxic substance management including legal, economic and technical issues. Topics will include characterization of hazardous materials, economics of toxics minimization, hazardous materials use, storage and disposal, basics of municipal solid waste and technical aspects of landfill siting, and selection and design of treatment technologies. Includes case studies of current waste management issues.  
Recommended: Bachelor’s degree in science or engineering.  
Lecture + Lab + Other: 3 + 0 + 0

ENVE F651  Environmental Risk Assessment  
3 Credits  
Offered Spring Odd-numbered Years  
The characterization of population exposures and the evidence used to identify environmental substances that may pose a human health risk. The theory and methods for estimating risk: hazard identification, dose-response assessment, exposure assessment and risk characterization.  
Recommended: Undergraduate degree in engineering or natural science.  
Lecture + Lab + Other: 3 + 0 + 0
ENVE F652  Introduction to Toxicology for Engineers and Scientists
3 Credits
Offered Fall Even-numbered Years
Introduction to the science of toxicology for graduate students in fields that use information about hazardous chemicals for input into decisions. Topics include an overview of the effects of chemicals on cells, organs and organ systems, and the toxic effects of classes of chemicals such as pesticides, metals and solvents. Use of data from animal testing and common lists, factors and extrapolation are reviewed.
**Recommended:** Undergraduate degree in engineering or natural science.
**Lecture + Lab + Other:** 3 + 0 + 0

ENVE F653  Environmental Measurements Laboratory
1 Credit
Offered Spring
Introduction to analytical methods and measurement techniques used in environmental engineering and environmental quality science. Students will design, conduct and report on a laboratory experiment. Includes sample preparation techniques and analytical methods such as microscopy, atomic adsorption spectroscopy, gas chromatography, liquid chromatography and mass spectrometry.
**Recommended:** ENVE F641.
**Lecture + Lab + Other:** 0 + 3 + 0

ENVE F698  Non-thesis Research/Project
1-9 Credits
**Lecture + Lab + Other:** 0 + 0 + 1-9

ENVE F699  Thesis
1-12 Credits
**Lecture + Lab + Other:** 0 + 0 + 1-12