

DEPARTMENT OF ENVIRONMENTAL SCIENCES AND ENGINEERING

Contact Information

Department of Environmental Sciences and Engineering

Visit Program Website (<http://www.sph.unc.edu/ese/>)

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Introduction

The Department of Environmental Sciences and Engineering combines the physical sciences, health sciences, engineering, and policy to address current and emerging environmental challenges. This multidisciplinary approach provides unique academic and research opportunities for students. Our undergraduate degree focuses on the environmental health sciences, with specific concentrations in environmental chemistry, environmental health biology, and environmental physics.

Advising

Academic advising is the responsibility of the co-director of undergraduate studies; individual research and professional student advising is distributed among the department's faculty members. Students interested in one of the concentrations will be advised and mentored by an environmental sciences and engineering faculty member whose expertise is relevant to the concentration. The program co-director and staff in the Office of Student Affairs will verify that coursework requirements for the concentration have been met. Undergraduate students are encouraged to meet regularly with the program co-director and review their course of studies each semester. The program director and the Office of Student Services staff work with current and prospective majors by appointment (see contact information above). Departmental academic advising is particularly important for those majors who are considering going on to the dual bachelor's–master's degree. Further information on courses, undergraduate research opportunities, the honors program, careers, and graduate schools may be obtained from the department's Web site (<http://sph.unc.edu/envr/environmental-sciences-and-engineering-home/>).

Facilities

The Department of Environmental Sciences and Engineering houses research laboratories located in Rosenau Hall, McGavran-Greenberg Hall, Michael Hooker Research Center, and the Baity Building. These laboratories are involved in important research in water quality, biogeochemistry, atmospheric chemistry and air pollution, effects of

environmental chemicals on DNA tissues and organisms, environmental and public health microbiology, and occupational health and safety.

The department also offers facilities for modeling and computational analysis of environmental systems, such as atmospheric circulation and air quality models, ground and surface water flow and transport models, fluid flow and contaminant transport models for indoor air environments, exposure analysis and health effects, risk assessment, and environmental epidemiology.

More detailed information about the individual laboratories and centers can be found at the department Web site (<http://www.sph.unc.edu/envr/>).

Graduate School and Career Opportunities

While undergraduate education prepares students for citizenship in ways that go beyond professional concerns, the program in environmental health sciences also provides skills needed for employment and graduate study. Students ending their studies at the undergraduate level gain skills necessary to work in positions such as risk analysts in consulting firms and regulatory agencies; research assistants in research laboratories; as environmental health specialists in local, state, and national environmental and environmental health departments; and scientific advisors to environmental organizations. The degree also prepares students for graduate study in the environmental sciences, environmental health sciences, environmental studies, toxicology, and professional disciplines such as medicine, dentistry, veterinary medicine, environmental law, and public health.

Undergraduate students with appropriate science backgrounds have the opportunity to pursue a dual bachelor's–master's degree. This program allows students to complete a master's degree in the department within one additional year of study beyond receipt of the bachelor's degree. Interested students should read the program description and requirements (<http://sph.unc.edu/envr/envr-degrees/>) carefully.

Students have opportunities to explore possibilities for employment through the rich network of connections among the department, University, and numerous environmental organizations in the Research Triangle Park area, which is home to the highest concentration of environmental health sciences groups in the nation.

Major

- Environmental Health Sciences Major, B.S.P.H. (<http://catalog.unc.edu/undergraduate/programs-study/environmental-health-sciences-major-bsph/>)

Professors

Michael D. Aitken, Louise M. Ball, Gregory W. Characklis, Michael R. Flynn, Rebecca C. Fry, Avram Gold, Jacqueline MacDonald Gibson, William G. Gray, Richard M. Kamens, Cass T. Miller, Glenn Morrison, Leena Nylander-French, Aaron Salzberg, Mark D. Sobsey, Jill Stewart, Jason D. Surratt, Barbara J. Turpin, Howard S. Weinberg, J. Jason West, Dale Whittington.

Associate Professors

Orlando Coronell, Kun Lu, Amanda Northcross, Marc L. Serre, William Vizuete.

Assistant Professors

Karsten Baumann, Wanda Bodnar, Radhika Dhingra, (https://sph.unc.edu/adv_profile/radhika-dhingra-phd/) Mike Fisher, Noah Kittner, Julia Rager, Courtney Woods, Zhenfa Zhang.

Joint Professors

John M. Bane, Ilona Jaspers, Richard A. Luettich Jr., Christopher S. Martens, David McNelis, Rachel T. Noble, Hans W. Paerl, Michael F. Piehler, Paul B. Watkins.

Adjunct Professors

Greg Allgood, Francis Binkowski, Linda S. Birnbaum, Clarissa Brocklehust, Gaylen R. Brubaker, Daniel L. Costa, David DeMarini, David Dix, Shabbir Gheewala, M. Ian Gilmour, David Leith, Wayne Litaker, Michael Madden, David Peden, Terrence K. Pierson, Joseph Pinto, Joachim Pleil, James Samet, Woodhall Stopford.

Adjunct Associate Professors

Sarav Arunachalam, John M. Dement, Havala O. T. Pye, Thomas B. Starr, Miroslav Styblo.

Adjunct Assistant Professors

Jacky Rosati, Roger Sit.

Adjunct Lecturer

Raymond Hackney.

Professors Emeriti

Richard N.L. Andrews, Russell F. Christman, Douglas J. Crawford-Brown, Francis A. DiGiano, Donald L. Fox, Donald E. Francisco, Harvey E. Jeffries, Donald L. Lauria, David H. Moreau, Frederic K. Pfaender, Mark Shuman, Philip C. Singer, Stephen C. Whalen, Donald Willhoit.

ENVR–Environmental Health Sciences Undergraduate-level

ENVR 89. First-Year Seminar: Special Topics. 3 Credits.

Special topics course. Content will vary each semester.

Grading status: Letter grade.

ENVR 190. Selected Topics in Undergraduate Studies. 1-3 Credits.

Permission of the instructor. Current topics of interest in environmental science and their application to understanding environmental issues are directed towards undergraduates. Topics and instructors will change.

One to three lecture hours per week.

Repeat rules: May be repeated for credit; may be repeated in the same term for different topics; 6 total credits. 2 total completions.

Grading status: Letter grade.

ENVR 205. Engineering Tools for Environmental Problem Solving. 3 Credits.

Introduction to mass, energy, and momentum transport applied to environmental problem solving. Students ask and answer policy-oriented questions (define systems, document assumptions, explain the value and limitations of quantitative answers). They will apply these tools to the design of engineered solutions and characterization of natural and perturbed systems.

Requisites: Prerequisite, MATH 231.

Gen Ed: PL, CI, QI.

Grading status: Letter grade.

ENVR 230. Environmental Health Issues. 3 Credits.

Examines key events that have shaped our understanding of the impacts of environmental agents on human health and uses them to introduce basic concepts in environmental health.

Grading status: Letter grade.

ENVR 240. Undergraduate Research Opportunities Program (UROP) Training. 1 Credit.

The purpose of this course is to provide structured research training among undergraduate students participating in the Undergraduate Research Opportunities Program (UROP). Formal acceptance into Undergraduate Research Opportunities Program (UROP) required.

Grading status: Letter grade.

ENVR 295. Undergraduate Research. 3 Credits.

Directed readings or laboratory study. Written reports are required. May be taken more than once for credit. Six to nine hours per week.

Repeat rules: May be repeated for credit. 6 total credits. 2 total completions.

Grading status: Letter grade.

ENVR 296. Readings in Environmental Sciences and Engineering. 1-9 Credits.

Advanced Undergraduate and Graduate-level

ENVR 400. Seminar Series. 1 Credit.

Presents the results of ongoing research projects in the Department of Environmental Sciences and Engineering. Topics and presenters are selected from among the departmental graduate students and faculty.

Grading status: Letter grade.

ENVR 403. Environmental Chemistry Processes. 3 Credits.

Required preparation, a background in chemistry and mathematics, including ordinary differential equations. Chemical processes occurring in natural and engineered systems: chemical cycles; transport and transformation processes of chemicals in air, water, and multimedia environments; chemical dynamics; thermodynamics; structure/activity relationships.

Grading status: Letter grade

Same as: ENEC 403.

ENVR 404. Life Cycle Assessment: Energy and the Environment. 3 Credits.

A systems approach to dealing with environmental pollution problems is highlighted and Life Cycle Assessment (LCA) is introduced as an assessment tool. Topics include basic environmental interactions; biogeochemical cycles and environmental impacts (global, regional, and local); and application of LCA to waste management and energy conversion systems; are addressed.

Grading status: Letter grade.

ENVR 411. Laboratory Techniques and Field Measurements. 3 Credits.

Students learn laboratory, field, and analytical skills. Provides a solid introduction to experimental research in environmental sciences and engineering. Students are provided with applications in limnology, aquatic chemistry, and industrial hygiene.

Grading status: Letter grade.

ENVR 412. Ecological Microbiology. 3 Credits.

Required preparation, one course in general microbiology. A description of microbial populations and communities, the environmental processes they influence, and how they can be controlled to the benefit of humankind.

Grading status: Letter grade.

ENVR 413. Limnology. 3 Credits.

Required preparation, introductory biology, chemistry, and physics. Basic aspects of freshwater ecosystem function. Emphasis on trophic-level interactions and integration of physical, chemical, and biological principles for a holistic view of lake ecosystem dynamics.

Grading status: Letter grade.

ENVR 416. Aerosol Physics and Chemistry. 4 Credits.

Permission of the instructor for nonmajors. Physical and chemical principles underlying behavior of particles suspended in air. Topics include rectilinear and curvilinear motion of the particles in a force field, diffusion, evaporation, and condensation, electrical and optical properties, and particle coagulation. Three lecture hours a week and two laboratory sessions.

Grading status: Letter grade.

ENVR 417. Oceanography. 3 Credits.

Required preparation, major in a natural science or two courses in natural sciences. Studies origin of ocean basins, seawater chemistry and dynamics, biological communities, sedimentary record, and oceanographic history. Term paper. Students lacking science background should see MASC 101. Students may not receive credit for both MASC 101 and MASC 401.

Grading status: Letter grade

Same as: MASC 401, BIOL 350, GEOL 403.

ENVR 419. Chemical Equilibria in Natural Waters. 3 Credits.

Principles and applications of chemical equilibria to natural waters. Acid-base, solubility, complex formation, and redox reactions are discussed. This course uses a problem-solving approach to illustrate chemical speciation and environmental implications. Three lecture hours per week.

Grading status: Letter grade.

ENVR 421. Environmental Health Microbiology. 3 Credits.

Required preparation, introductory course in microbiology or permission of the instructor. Presentation of the microbes of public health importance in water, food, and air, including their detection, occurrence, transport, and survival in the environment; epidemiology and risks from environmental exposure. Two lecture and two laboratory hours per week.

Grading status: Letter grade.

ENVR 423. Industrial Toxicology. 3 Credits.

Toxicological assessment of and a case presentation of related exposure is given. A conceptual approach is utilized to design appropriate programs to prevent worker ill health due to toxicant exposure

Grading status: Letter grade.

ENVR 425. Introduction to Health Physics: Radiation and Radiation Protection. 3 Credits.

This course concentrates on fundamentals of radiation and protection, including types of radiation, radioactive decay, interaction with matter, biological effects, detection and measurement, protection methods/techniques, external and internal dose, etc. Lectures include hazards in categories of environmental radiation, nuclear energy, medical applications, industrial uses, etc.

Grading status: Letter grade.

ENVR 430. Health Effects of Environmental Agents. 3 Credits.

Required preparation, basic biology, chemistry through organic, calculus. Permission of the instructor for students lacking this preparation. Interactions of environmental agents (chemicals, infectious organisms, radiation) with biological systems including humans, with attention to routes of entry, distribution, metabolism, elimination, and mechanisms of adverse effects. Three lecture hours per week.

Grading status: Letter grade.

ENVR 431. Techniques in Environmental Health Sciences. 2 Credits.

Required preparation, basic biology, chemistry through organic, math through calculus; permission of the instructor for students lacking this preparation. A practical introduction to the measurement of biological end-points, emphasizing adverse effects of environmental agents, using laboratory and field techniques. Two laboratory hours per week.

Grading status: Letter grade.

ENVR 432. Occupational Safety and Ergonomics. 3 Credits.

Fundamentals of occupational safety and ergonomics with emphasis on legislation and organization of industrial safety and ergonomic programs, including hazard recognition, analysis, control, and motivational factors pertaining to industrial accident and cumulative trauma disorder prevention.

Grading status: Letter grade.

ENVR 433. Health Hazards of Industrial Operation. 3 Credits.

An introduction to the health hazards associated with the various unit operations of industry. Field trips to local industries planned.

Grading status: Letter grade.

ENVR 442. Biochemical Toxicology. 3 Credits.

Required preparation, one course in biochemistry. Biochemical actions of toxicants and assessment of cellular damage by biochemical measurements. Three lecture hours per week.

Requisites: Prerequisite, CHEM 430; permission of the instructor for students lacking the prerequisites.

Grading status: Letter grade

Same as: BIOC 442, TOXC 442.

ENVR 451. Elements of Chemical Reactor Engineering. 3 Credits.

Focuses on chemical reaction rates and reaction mechanisms. Covers mole balances, rate laws, chemical kinetics, and reactor design. Principles are applied to any environmental system where chemical transformations must be described. Three lecture hours per week.

Grading status: Letter grade.

ENVR 452. Fluid Dynamics. 3 Credits.

The physical properties of fluids, kinematics, governing equations, viscous incompressible flow, vorticity dynamics, boundary layers, irrotational incompressible flow.

Requisites: Prerequisite, PHYS 401; permission of the instructor for students lacking the prerequisite.

Grading status: Letter grade

Same as: MASC 560, GEOL 560, PHYS 660.

ENVR 453. Groundwater Hydrology. 3 Credits.

Required preparation, math through differential equations and some familiarity with fluid mechanics. Conservation principles for mass, momentum, and energy developed and applied to groundwater systems. Scope includes the movement of water, gas, and organic liquid phases, the transport and reaction of contaminants. Three lecture hours per week.
Grading status: Letter grade.

ENVR 468. Temporal GIS and Space/Time Geostatistics for the Environment and Public Health. 3 Credits.

Reviews geographical information systems (GIS). Covers geostatistics theory for the interpolation of environmental and health monitoring data across space and time. Uses publicly available water and air quality monitoring data to create maps used for environmental assessment, regulatory compliance analysis, exposure science, and risk analysis.
Requisites: Prerequisite, MATH 232; permission of the instructor for students lacking the prerequisite.

Grading status: Letter grade
Same as: ENEC 468.

ENVR 470. Environmental Risk Assessment. 3 Credits.

Required preparation, one course in probability and statistics. Use of mathematical models and computer simulation tools to estimate the human health impacts of exposure to environmental pollutants. Three lecture hours per week.

Grading status: Letter grade
Same as: ENEC 470.

ENVR 472. Quantitative Risk Assessment in Environmental Health Microbiology. 3 Credits.

Recommended preparation, microbiology, epidemiology, and infectious diseases. Survey of alternative approaches, frameworks, and decision-making tools for quantitative risk assessment of microbial pathogens that infect humans and cause disease by the exposure routes of water, food, air, and other vehicles.

Grading status: Letter grade.

ENVR 475. Global Climate Change: Interdisciplinary Perspectives. 1 Credit.

This class addresses the complexity and importance of global climate change from several disciplines. A top expert will lecture each week, addressing several themes including the science of human influences on climate, impacts and adaptation, global energy and technology, communication, and economics and international solutions. Pass/Fail only.

Grading status: Pass/Fail.

ENVR 480. Modeling of Marine and Earth Systems. 1-3 Credits.

Mathematical modeling of dynamic systems, linear and nonlinear. The fundamental budget equation. Case studies in modeling transport, biogeochemical processes, population dynamics. Analytical and numerical techniques; chaos theory; fractal geometry.

Requisites: Prerequisite, MATH 232; permission of the instructor for students lacking the prerequisite.

Grading status: Letter grade
Same as: MASC 480, GEOL 480.

ENVR 500. Environmental Processes, Exposure, and Risk Assessment. 3 Credits.

Environmental chemical and biological transport and transformation, exposure to environmental contaminants, and environmental risk assessment.

Requisites: Prerequisite, CHEM 261.
Grading status: Letter grade.

ENVR 505. Chemical Oceanography. 4 Credits.

Graduate students only; undergraduates must have permission of the instructor. Overview of chemical processes in the ocean. Topics include physical chemistry of seawater, major element cycles, hydrothermal vents, geochemical tracers, air-sea gas exchange, particle transport, sedimentary processes, and marine organic geochemistry. Three lecture and two recitation hours per week.

Gen Ed: PL.
Grading status: Letter grade
Same as: MASC 505, GEOL 505.

ENVR 514. Measurement of NO_x, O₃, and Volatile Organic Compounds. 3 Credits.

This course is intended to develop a student's ability to operate the primary instruments for measuring these important pollutants, collect and process samples where necessary, record data, and process instrument data into final air concentration data.

Grading status: Letter grade.

ENVR 520. Biological Oceanography. 4 Credits.

For graduate students; undergraduates need permission of the instructor. Marine ecosystem processes pertaining to the structure, function, and ecological interactions of biological communities; management of biological resources; taxonomy and natural history of pelagic and benthic marine organisms. Three lecture and one recitation hours per week. Two mandatory weekend fieldtrips.

Gen Ed: PL.
Grading status: Letter grade
Same as: MASC 504, BIOL 657.

ENVR 522. Environmental Change and Human Health. 3 Credits.

The course will provide students with a multidisciplinary perspective of environmental changes to encompass both human health and ecological health.

Requisites: Prerequisite, ENEC 201 or 202.
Grading status: Letter grade
Same as: ENEC 522.

ENVR 525. Water, Sanitation, Hygiene, and Global Health. 3 Credits.

Builds on an understanding of infectious and toxic hazards, disease causation, and environmental transmission. Deals with hazard and disease classification; safety, risk, and vulnerability; interventions and their health impact; approaches in different settings; distal factors (e.g., water scarcity, climate change); and approaches to studying unsafe water, sanitation, and hygiene. Previously offered as ENVR 682.

Grading status: Letter grade.

ENVR 552. Organic Geochemistry. 3 Credits.

Recommended preparation, CHEM 261 or MASC 505, and one additional ENVR, GEOL, or MASC course above 400. Sources, transformations, and fate of natural organic matter in marine environments. Emphasis on interplay of chemical, biological, and physical processes that affect organic matter composition, distribution, and turnover.

Gen Ed: PL.
Grading status: Letter grade
Same as: MASC 552, GEOL 552.

ENVR 570. Methods of Environmental Decision Analysis. 3 Credits.

Required preparation, one course in probability and statistics. Use of quantitative tools for balancing conflicting priorities (such as costs versus human health protection) and evaluating uncertainties when making environmental decisions.

Grading status: Letter grade.

ENVR 575. Global Climate Change: Science, Impacts, Solutions. 3 Credits.

This class addresses the importance of climate change in its entirety. The first half of the course addresses climate science, followed by climate change impacts, energy and mitigation technologies, economics, and international politics. Improving communication and quantitative skills is emphasized through homework, in-class presentations, and a research paper.

Grading status: Letter grade.

ENVR 580. Policy Design for Environmental Health Solutions. 3 Credits.

Students will be introduced to the types of policy instruments that can be used to solve environmental health problems. The course provides a framework for understanding the tasks involved, the main institutions responsible, and an in-depth description of the policy instruments used to tackle environmental health problems.

Grading status: Letter grade.

ENVR 582. Sanitation for Development. 3 Credits.

Over a million children die yearly from diarrhea, in part because 2.0 billion humans do not have access to a basic toilet. This course presents the problems and context of inadequate sanitation in the developing world, and, more importantly, the types of solutions and approaches available to reduce these problems.

Gen Ed: PL, GL.

Grading status: Letter grade.

ENVR 585. American Environmental Policy. 3 Credits.

Intensive introduction to environmental management and policy, including environmental and health risks; policy institutions, processes, and instruments; policy analysis; and major elements of American environmental policy. Lectures and case studies. Three lecture hours per week.

Gen Ed: HS, NA.

Grading status: Letter grade

Same as: ENEC 585, PLAN 585, PLCY 585.

ENVR 593. Undergraduate Practicum in Environmental Health Sciences. 1-3 Credits.

A practical experience in a setting relevant to environmental health.

Gen Ed: EE- Academic Internship.

Repeat rules: May be repeated for credit. 6 total credits. 2 total completions.

Grading status: Letter grade.

ENVR 600. Environmental Health. 3 Credits.

This course examines the relationship between environmental quality, human health and welfare, with particular attention to contamination in human environment; physical, biological, and social factors; trade-offs regarding prevention and remediation measures. Satisfies core School of Public Health requirement. Three lecture hours per week.

Grading status: Letter grade.

ENVR 601. Epidemiology for Environmental Scientists. 3 Credits.

An introduction to relevant epidemiologic concepts that inform environmental science research. Learning objectives include discussing basic epidemiologic concepts and measures of disease occurrence in populations, explaining epidemiological study designs for studying associations between risk factors or exposures in populations, evaluating epidemiologic evidence, and comprehending basic ethical principles.

Grading status: Letter grade.

ENVR 610. Global Perspectives on Environmental Health Inequalities. 3 Credits.

Students will learn about how social, economic, and political factors impact environmental health outcomes and will be introduced to theories and methods for incorporating social determinants frameworks into environmental health research, as well as the role of environmental justice movements.

Grading status: Letter grade.

ENVR 630. Systems Biology in Environmental Health. 3 Credits.

Required preparation, one year of biology. Environmental systems biology examines how environmental stressors influence the components of a biological system, and how the interactions between these components result in changes in the function and behavior of that system.

Grading status: Letter grade.

ENVR 640. Environmental Exposure Assessment. 3 Credits.

Permission of the instructor for nonmajors. The course material introduces the general concepts of assessing environmental exposures to chemicals in human populations. This includes the design of ecologic and personal monitoring studies, the techniques and equipment used for sampling and analysis, and interpretation of data.

Grading status: Letter grade.

ENVR 650. Principles of Chemical Carcinogenesis. 2 Credits.

Required preparation, organic chemistry. Bioactivation of carcinogens, interaction of activated metabolites with DNA, and their effects on DNA structure, replication, repair, and the control of these processes during development of chemically induced carcinogenesis. Two lecture hours per week.

Grading status: Letter grade.

ENVR 661. Scientific Computation I. 3 Credits.

Requires some programming experience and basic numerical analysis. Error in computation, solutions of nonlinear equations, interpolation, approximation of functions, Fourier methods, numerical integration and differentiation, introduction to numerical solution of ODEs, Gaussian elimination.

Grading status: Letter grade

Same as: MATH 661.

ENVR 662. Scientific Computation II. 3 Credits.

Theory and practical issues arising in linear algebra problems derived from physical applications, e.g., discretization of ODEs and PDEs. Linear systems, linear least squares, eigenvalue problems, singular value decomposition.

Requisites: Prerequisite, MATH 661.

Grading status: Letter grade

Same as: MATH 662, COMP 662.

ENVR 666. Numerical Methods. 3 Credits.

Numerical methods for solving problems arising in sciences and engineering. Solution of linear equations using direct and iterative approaches, solution of nonlinear systems of algebraic equations, solution of ordinary differential equations including single and multistep methods, and methods for stiff systems of ODEs and collocation methods for linear and nonlinear PDEs.

Requisites: Prerequisites, COMP 116 and MATH 383.

Grading status: Letter grade.

ENVR 668. Methods of Applied Mathematics I. 3 Credits.

Requires an undergraduate course in differential equations. Contour integration, asymptotic expansions, steepest descent/stationary phase methods, special functions arising in physical applications, elliptic and theta functions, elementary bifurcation theory.

Grading status: Letter grade

Same as: MATH 668.

ENVR 669. Methods of Applied Mathematics II. 3 Credits.

Perturbation methods for ODEs and PDEs, WKBJ method, averaging and modulation theory for linear and nonlinear wave equations, long-time asymptotics of Fourier integral representations of PDEs, Green's functions, dynamical systems tools.

Requisites: Prerequisite, MATH 668.

Grading status: Letter grade

Same as: MATH 669.

ENVR 671. Environmental Physics I. 3 Credits.

A first graduate-level course in physical principles relevant to environmental systems. Topics include dimensional analysis, tensor calculus, conservation of mass and momentum. Applications are considered from natural and engineered systems and across all relevant media. Focus is on the development of mechanistic representation of environmental systems.

Grading status: Letter grade.

ENVR 672. Environmental Physics II. 3 Credits.

Second part of a graduate-level sequence in physical principles relevant to environmental systems. Topics include turbulence, conservation of energy, multiscale methods, and thermodynamics. Applications are considered from natural and engineered systems and across all relevant media. Focus is on development of mechanistic representation of environmental systems.

Requisites: Prerequisite, ENVR 671.

Grading status: Letter grade.

ENVR 673. Hydraulics for Environmental Engineering. 3 Credits.

Permission of the instructor for undergraduates. This course teaches practical basics of how to solve environmental engineering problems in the hydraulics of pipes, pumps, networks, and open channels. The course is a mix of classroom lectures, problem-solving sessions, and laboratory sessions.

Requisites: Prerequisites, MATH 231 and PHYS 114.

Grading status: Letter grade.

ENVR 675. Air Pollution, Chemistry, and Physics. 3 Credits.

This class is designed for graduate students planning for research in air pollution, emphasizing chemical kinetics and engineering approaches to problem solving in addition to atmospheric structure, meteorology, and modeling. We address problems of stratospheric and tropospheric ozone, particulate matter, and acid rain. We emphasize quantitative problem solving in homework.

Grading status: Letter grade.

ENVR 683. Water-Health Research I. 2 Credits.

Permission of the instructor for undergraduates and nonmajors. Introduces students to methods for research conception, design, planning, and implementation in fields related to water and its impacts on health. Students study approaches and tools that may be applied in water-related research and are coached in developing their own research design.

Grading status: Letter grade.

ENVR 684. Water-Health Research II. 2 Credits.

Permission of the instructor for undergraduates and nonmajors. Familiarizes students with the principles of scientific communication with an emphasis on scientific writing and oral presentations. Using their own water and health research, students learn how to communicate effectively in informal settings and how to prepare for interviews with the media.

Grading status: Letter grade.

ENVR 685. Water and Sanitation Planning and Policy in Less Developed Countries. 3 Credits.

Permission of the instructor. Seminar on policy and planning approaches for providing improved community water and sanitation services in developed countries. Topics include the choice of appropriate technology and level of service, pricing, metering, and connection charges; cost recovery and targeting subsidies to the poor; water venting; community participation in the management and operation of water systems; and rent-seeking behavior in the provision of water supplies.

Grading status: Letter grade

Same as: PLAN 685.

ENVR 686. Policy Instruments for Environmental Management. 3 Credits.

Design of public policy instruments as incentives for sustainable management of environmental resources and ecosystems, and comparison of the effects and effectiveness of alternative policies.

Requisites: Prerequisite, ECON 410 or PLAN 710.

Gen Ed: SS.

Grading status: Letter grade

Same as: PLCY 686, ENEC 686, PLAN 686.

ENVR 687. Writing for Journal Publication on Water and Sanitation Hygiene, Health, and Development. 2 Credits.

This course familiarizes students with scientific paper writing and coaches students towards journal manuscript submission. Students should have a data set of results. Sessions begin with student presentations and discussion, followed by a brief preparatory lecture on the next assignment. Substantive preparation is required between sessions.

Grading status: Letter grade.

ENVR 691H. Honors Research. 3 Credits.

Permission of the instructor. Directed readings or laboratory study of a selected topic. A written report is required in the form of an honors thesis (ENVR 692H).

Gen Ed: EE- Mentored Research.

Repeat rules: May be repeated for credit. 6 total credits. 2 total completions.

Grading status: Letter grade.

ENVR 692H. Honors Thesis. 3 Credits.

Students complete honors research projects.

Gen Ed: EE- Mentored Research.

Grading status: Letter grade.

ENVR 695. Undergraduate Research. 1-3 Credits.

Directed readings or laboratory study. Written reports are required. May be taken more than once for credit. Three to nine hours per week.

Gen Ed: EE- Mentored Research.

Repeat rules: May be repeated for credit. 6 total credits. 2 total completions.

Grading status: Letter grade.

ENVR 698. Senior Capstone Course. 3 Credits.

This capstone course covers a range of issues in public health ethics, particularly focused on environmental health. Students will work on a team-based project over the course of the semester. The projects will be focused on topics that have ethical relevance and will integrate students' knowledge in environmental health.

Gen Ed: EE- Mentored Research.

Grading status: Letter grade.