051 First Year Seminar: Global Warning: Serious Threat or Hot Air? (3). Students will examine evidence that human activity has caused global warming, investigate scientists' ability to predict climate change, and discuss the political and social dimensions of global climate change.

052 First Year Seminar: Living with Our Oceans and Atmosphere (3) Modern theories of changing weather, severe weather events, oceanic hazards, interactions between the oceans and atmosphere, and changes that are linked to human activity.

053 First Year Seminar: The Ends of the Earth: Polar Oceanography and Exploration (3) What explains the "pull of the poles"? This seminar combines a modern survey of polar oceanography with historical views of early polar explorations, as reported by the explorers themselves.

055 First Year Seminar: Change in the Coastal Ocean (3) This course provides an opportunity to explore changes in marine and closely-linked terrestrial environments, caused by the interactions of fascinating oceanographic processes. Introductory presentations and discussions will focus on published works of active marine scientists, who combine disciplinary training with knowledge and skills from other fields.

057 First Year Seminar: From "The Sound of Music" to "The Perfect Storm" (3) Students will develop the conceptual framework necessary to understand waves of any kind, starting from laboratory observations.

058 First Year Seminar: Connections to the Sea: The Challenges Faced by Using and Living Near Coastal Inlets (3) This course explores the natural history of several inlets, impact of human intervention, and political/policy challenges faced; includes several group projects/presentations and a field trip to a coastal inlet.

059 First Year Seminar: Extreme Microorganisms: Pushing the Limits of Life on Earth and Beyond (3) We will expand our horizons in biology by learning about some of the most extreme microorganisms on the planet--microorganisms that thrive without oxygen, under high temperatures (for example, in pressurized water above the boiling point), and under chemical stress factors (high sulfide and heavy metal concentrations) that were once thought to be incompatible with life.

101 The Marine Environment (GEOL 103) (3). Introduction to natural science emphasizing physical, chemical, biological and geological phenomena in oceanic and coastal environments. Human use of, and impact on, marine resources. Open to undergraduate non-science majors (science majors see MASC 401). Fall and Spring.

108 Our Energy and Climate Crisis: Challenges and Opportunities (PWAD 108, ENST 108, GEOL 108, PHYS 108) (4) Students quantify global depletion of energy resources and accompanying environmental degradation, discovering the profound changes in attitudes and behavior required to adjust to diminished fossil fuels and modified climate.

220 North Carolina Estuaries: Environmental Processes and Problems (ENST 222) (3) Natural processes and human impacts on estuarine systems using the Neuse River estuary as a case study. Course includes one week of intensive field work based at the Institute of Marine Sciences. A student may not receive credit for this course after receiving credit for ENST 222.


312 From the Equator to the Poles: Case Studies in Global Environmental Change (ANTH 312) (3). Case studies in environmental change, highlighting human and environmental dynamics in terrestrial and marine ecosystems on multiple spatial and temporal scales. Includes active learning modules, group presentations and writing assignments.

314 Earth Systems in a Changing World (3). This course presents an integrated view of our planet, how it evolved during the past, why it has changed (and continues to change) and what makes earth a habitable planet.

395 Undergraduate Research in Marine Sciences (2-4) Permission of a faculty research director. Directed readings with laboratory study on a selected topic.

401 Oceanography (BIOL 350, ENVR 417, GEOL 403) (3). Prerequisites, major in a natural science or at least two college-level courses in natural sciences. The origin of ocean basins, chemistry and dynamics of seawater, biological communities and processes, the sedimentary record, and the history of oceanography. Term paper. Intended for students with college science background; other students should see GEOL 103. Three lecture hours a week.

410 Earth Processes in Environmental Systems (ENST 410, GEOL 410) (4). Prerequisites, CHEM 102, GEOL 111 or 213, MATH 231, PHYS 105 or 117. Permission of the instructor for students lacking the prerequisites. Principles of geological and related Earth systems sciences are applied to analyses of environmental phenomena. The link between the lithosphere and other environmental compartments is explored through case studies of environmental issues. Three lecture hours and one laboratory hour a week.

411 Oceanic Processes in Environmental Systems (ENST 411, GEOL 411) (4). Prerequisites, BIOL 101, CHEM 102, ENST 222, MATH 231, PHYS 105 or 117. Permission of the instructor for students lacking the prerequisites. Principles of analysis of the ocean, coast, and estuarine environments and the processes that control these environments are applied to the analysis of environmental phenomena. Case studies of environmental issues. Three lecture hours and one laboratory hour a week.

415 Environmental Systems Modeling (ENST 415, ENVR 461, GEOL 415) (3). Prerequisites, MATH 383, PHYS 105 or PHYS 117 (may be taken concurrently), or permission of instructor. Methods for developing explanatory and predictive models of environmental processes are explored. Includes discussion of the relevant scientific modes of analysis, mathematical methods, computational issues and visualization techniques. Two lecture hours and one computer lab hour a week.

430 Coastal Sedimentary Environments (GEOL 430) (3). Prerequisite, GEOL 56 or permission of instructor. An introduction to modern shallow-water classic environments and their sediments, emphasizing barrier islands, deltas, estuaries, wetlands, and tidal flats. Includes local field trips and discussion/application of data collecting techniques.

431 Micropaleontology (GEOL 431) (4). Prerequisite, Invertebrate Paleontology 132, or Marine Ecology 440, or permission of instructor. An in-depth study of the biostratigraphy, paleoecology, and taxonomy of various microfossil groups (i.e., Foraminifera, ostracodes, conodonts, coccoliths, Radiolaria, diatoms, acritarchs, dinoflagellates, etc.) dependent upon individual student objectives. Three lecture and three laboratory hours a week. On demand.

432 Major Rivers and Global Change: Mountains to the Sea (3). What are the linkages between rivers and global change? This course examines the hydrological, geological, and biogeochemical processes that control material flux from land to the oceans via rivers.
436 Coastal Processes (4) An interdisciplinary description and analysis of environmental processes that form and maintain coastal habitats. Coastal aspects of geology, fluid dynamics, chemistry and biology are considered. Two lectures per week and two coastal fieldtrips.

440 Marine Ecology (BIOL 462) (3). Prerequisites, BIOL 201 or 475. A survey of ecological and oceanographic processes structuring marine communities in a broad range of habitats with an emphasis on experimental approaches to addressing both basic and applied problems in marine systems. Three lecture hours a week.

441 Marine Physiological Ecology (3) This course will introduce students to the physiological, morphological, and behavioral factors employed by marine organisms to cope with their physical environment. Emphasis will be placed on the response of marine organisms to environmental factors such as seawater temperature, light, water salinity, ocean acidification etc.

442 Marine Biology (BIOL 457) (3). Prerequisites, MASC 101 or BIOL 101. A survey of plants and animals that live in the sea: characteristics of marine habitats, organisms, and the ecosystems will be emphasized. Marine environment, the organisms involved, and the ecological systems that sustain them.

443 Marine Microbiology (3) Restricted to junior or senior science majors or graduate students, with permission of the instructor. Seminar class focuses on the primary research literature. Physiology of marine microorganisms, microbial diversity and ecology of the marine environment, biogeochemical processes catalyzed by marine microorganisms.

444 Marine Phytoplankton (3) Permission of the instructor. For junior and senior science majors or graduate students. Biology of marine photosynthetic protists and cyanobacteria. Phytoplankton evolution, biodiversity, structure, function, biogeochemical cycles and genomics. Harmful algal blooms, commercial products, and climate change. Three lecture and one laboratory hours per week.

445 Marine Invertebrate Biology (BIOL 475) (4). Prerequisites, BIOL 101 and 101L and one additional course in biology. An introduction to the major animal phyla emphasizing form, function, behavior, ecology, evolution and classification of marine invertebrates. Three lecture and three laboratory hours per week.

448 Coastal and Estuarine Ecology (ENST 472) (4). Prerequisites, CHEM 102 and MATH 231. A field intensive study of the ecology of marine organisms and their interactions with their environment, including commercially important organisms. Laboratory/recitation/field work is included and contributes 2 credit hours to the course.

450 Biogeochemical Processes in Environmental Systems (ENST 450, ENVR 415, GEOL 450) (3). Prerequisites, MATH 231; BIOL 101; CHEM 251 or 261; PHYS 105 or 117; GEOL 111 or GEOL 213; or permission of instructor. Principles of chemistry, biology and geology are applied to analysis of the fate and transport of materials in environmental systems, with an emphasis on those materials that form the most significant cycles. The course examines these processes in systems that contain the hydrosphere, lithosphere, atmosphere and biosphere. Three lecture hours and one lab hour a week.

460 Fluid Dynamics of the Environment (3) Prerequisite, MATH 232. Permission of the instructor for students lacking the prerequisite. Principles and applications of fluid dynamics to flows of air and water in the natural environment. Conservation of momentum, mass, and energy applied to lakes, rivers, estuaries, and the coastal ocean. Dimensional analysis and scaling emphasized to promote problem-solving skills.

470 Estuarine and Coastal Marine Science (ENST 222) (4). Prerequisites, Math 231 and either PHYS 104 or CHEM 101. Introduction to estuarine and coastal environment: geomorphology, physical circulation, nutrient loading, primary and secondary production, carbon and nitrogen cycling, benthic processes, and sedimentation. Consideration given to human impact on coastal systems with emphasis on North Carolina estuaries and sounds. Includes a mandatory weekend field trip and recitation. Fall.
**471 Human Impacts on Estuarine Ecosystems** (ENST 471) (4). Prerequisites, CHEM 102 and MATH 231. A cohesive examination of the human impacts on biological processes in estuarine ecosystems. Laboratory/recitation/field work is included and contributes two credit hours to the course.

**472 Barrier Island Ecology and Geology** (6). Prerequisite, courses in general ecology and geology, or permission of instructor. An integration of barrier island plant and animal ecology within the context of physical processes and geomorphological change. Emphasis on management and impact of human interference with natural processes.

**480 Modeling of Marine and Earth Systems** (ENVR 160, GEOL 480) (1-3). Prerequisite, MATH 232 or permission of the instructor. Mathematical modeling of the dynamic system, linear and nonlinear. The fundamental budget equation. Case studies in modeling convective transport, biogeochemical process, population dynamics. Analytical and numerical techniques, chaos theory, fractal geometry. Three lecture hours per week.

**483 Geologic and Oceanographic Applications of Geographical Information Systems** (GEOL 483) (4). Prerequisites, four natural science courses or permission of instructor. Focus on applying GIS concepts and techniques to mining and petroleum geology, resource assessment, hydrogeology, coastal and marine geology, physical oceanography, engineering geology, and a geologic perspective on land use.

**490 Special Topics in Marine Sciences for Undergraduates and Graduates** (2-4). Prerequisites, science background and permission of the instructor. Directed readings, laboratory, and/or field study of marine science topics not covered in scheduled courses.

**503 Marine Geology** (GEOL 503) (4). Prerequisite, Geology 101 or 111, or permission. Ocean basin origin, continental margin development, coastal geology, carbonate platforms arid pelagic sediments are subjects covered; paleoceanographic reconstructions are emphasized. Three lecture and two laboratory hours a week. Fall.

**504 Biological Oceanography** (BIOL 657, ENVR 520) (4). Prerequisites, BIOL 201 or 475 or permission. Physical, chemical and biological factors characterizing estuarine and marine environments emphasizing factors controlling animal and plant populations, including methods of analysis, sampling, and identification. Four lecture hours per week plus field trips. Spring.

**505 Chemical Oceanography** (GEOL 505) (4). Prerequisite, one semester of physical chemistry or CHEM 480, or permission of instructor. Variation and abundance of sea water constituents, the chemical, physical and biological processes contributing to their distribution as well as problems of dispersion of conservative and nonconservative substances. Three lecture and two recitation hours a week. Spring.

**506 Physical Oceanography** (GEOL 506) (4). Prerequisites, Math 231, 232, PHYS 104, 105, or permission. Descriptive regional oceanography, equations of motion, the Ekman layer, wind-driven currents, thermohaline circulation modern observations. waves, tides. Four lecture hours a week. Fall.

**550 Biogeochemical Cycling** (GEOL 550) (3). Prerequisites, MASC (GEOL) 553 or 440 or GEOL510, or ENVR421, or MASC 505, or permission of instructor. Biogeochemical cycling explores interfaces between marine, aquatic, atmospheric and geological sciences emphasizing processes controlling chemical distributions in sediments, fresh and salt water, the atmosphere, and fluxes between these reservoirs.

**552 Organic Geochemistry** (GEOL 552) (3) Prerequisites, MASC 505 or CHEM 261, or permission of instructor. Sources, transformations, and fate of natural organic matter in marine environments. Emphasis on interplay of chemical, biological, and physical processes which affect organic matter composition, distribution, and turnover.

**553 Geochemistry** (GEOL 512) (3). Prerequisites, GEOL 403 or 111, CHEM 102, or permission of the
instructor. Introduction to the application of chemical principles to geological problems, with emphasis on isotopic methods.

**560 Fluid Dynamics** (GEOL 560, ENVR 452, PHYS 660) (3). Prerequisite, Physics 103 or permission. The physical properties of fluids, kinematics, governing equations, viscous incompressible flow, vorticity dynamics, boundary layers, irrotational incompressible flow. Three lecture hours a week.


**562 Turbulent Boundary Layers** (2). Prerequisites: MASC 506 or MASC 560, or permission from instructor. Turbulence and transport in near-bottom boundary regions. Turbulence and mixing theory in boundary layers. Field deployment and recovery of turbulence measuring instruments. Data analysis from turbulence measurements.

**563 Descriptive Physical Oceanography** (GEOL 563) (3). Prerequisites, MASC 506 or permission. Observed structure of the large-scale and mesoscale ocean circulation and its variability, based on modern observations. In situ and remote sensing techniques, hydrographic structure, circulation patterns, ocean-atmosphere interactions. Three lecture hours a week.

**705 How to Give a Seminar** (1). Discussion of methods and strategies for giving effective technical presentations. Topics will include seminar structure, use of visual aids, personal and professional presentation, and responding to questions.

**706 Seminar in Oceanography** (1). Discussion of theories and research concerning ocean systems. Topics will stress the interactions between physical, chemical, geological, and biological processes in the sea. Separate sections will be offered at UNC-CH and at the Institute of Marine Sciences, Morehead City. Fall and Spring.

**741 Seminar in Marine Biology** (2). Discussion of selected literature in the field of marine biology, ecology, and evolution.

**742 Molecular Population Biology** (BIOL 752) (4). Prerequisite, BIOL 471 and permission of instructor. Hands-on training, experience, and discussion of the application of molecular genetic tools to questions of ecology, evolution, systematics, and conservation.

**750 Modeling Diagenetic Processes** (3). Prerequisite, MASC 480 or permission of instructor. An introduction to the theory and application of modeling biogeochemical processes in sediments. Diagenetic theory, numerical techniques, and examples of recently developed sediment models. Three lecture hours a week.

**761 Geophysical Fluid Dynamics** (3). Prerequisites, MASC 560, MATH 528, or permission from instructor. Momentum equations in a rotating reference frame, vorticity, potential vorticity, circulation, the shallow water model, Rossby and Kelvin waves, the Ekman layer. Three lecture hours a week.

**762 Ocean Circulation Theory** (3). Prerequisites, MASC 506, MASC 560, MATH 529, or permission from instructor. Theories, models of large scale dynamics of ocean circulation. Potential vorticity, quasi-geostrophy, instabilities.

**763 Coastal Circulation** (3). Prerequisites, MASC 506, MASC 560, MATH 529, or permission from instructor. Dynamics of the coastal ocean. Shallow water equations, boundary layer and long wave theory, wind driven circulation, fronts, estuaries.

**764 Ocean Circulation Modeling** (3). Prerequisites, MASC 506, MATH 529, or permission from instructor. Computational methods used in modeling oceanic circulation. Numerical solution of equations governing mass, momentum and energy equations.

781 Numerical ODE/PDE I (MATH 761, ENVR 761) (3). Single, multistep methods for ODEs: stability regions, the root condition; stiff systems, backward difference formulas; two-point BVPs; stability theory; finite difference methods for linear advection diffusion equations.

782 Numerical ODE/PDE II (MATH 762, ENVR 762) (3). Elliptic equation methods (finite differences, elements, integral equations); hyperbolic conservation law methods (Lax-Friedrich, characteristics, entropy condition, shock tracking/capturing); spectral, pseudo-spectral methods; particle methods, fast summation, fast multipole/vortex methods.

783 Mathematical Modeling I (MATH 768, ENVR 763) (3). Nondimensionalization and identification of leading order physical effects with respect to relevant scales and phenomena; deviation of classical models of fluid mechanics (lubrication, slender filament, thin filing, Stokes flow); deviation of weakly nonlinear envelope equations.

784 Mathematical Modeling II (MATH 769, ENVR 764) (3). Current models in science and technology: topics ranging from material science applications (e.g. flow of polymers and LCPs); geophysical applications (e.g., ocean circulation, quasi-geostrophic models, atmospheric vortices).

940 Research in Marine Sciences (2 or more).

992 Master's Thesis (3 or more).

994 Doctoral Dissertation (3 or more).