DEPARTMENT OF MARINE SCIENCES (GRAD)

Contact Information

Department of Marine Sciences
Visit Program Website (http://www.marine.unc.edu)

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The Department of Marine Sciences provides teaching and research in estuarine, coastal, and oceanographic sciences leading to M.S. and Ph.D. degrees in marine sciences. The two elements of the program are the Department of Marine Sciences (MASC) located in Murray Venable Hall on the Chapel Hill campus and the Institute of Marine Sciences (IMS) located on the waterfront in Morehead City, North Carolina. The Department of Marine Sciences is the degree granting-unit; all marine sciences graduate students are enrolled in the department. IMS faculty have joint faculty appointments in the department, and this enables their participation in graduate student academic activities. Research programs in physical oceanography, marine biology and ecology, marine geochemistry, marine geology, and coastal meteorology are conducted in North Carolina and throughout the world by faculty from the department and the IMS.

Courses and facilities at other coastal laboratories are also available to UNC–Chapel Hill marine sciences students through cooperative agreements. Courses at North Carolina State University, UNC–Charlotte, UNC–Greensboro, North Carolina Central University, and Duke University may be taken for credit through an interinstitutional registration program.

Requirements for Admission

For admission to the Department of Marine Sciences, an undergraduate degree is required in a basic science such as physics, mathematics, chemistry, biology, bacteriology, botany, zoology, geology, or in computer science or engineering. Students are advised to develop a broad undergraduate science major with as many as possible of the following courses: mathematics through calculus, computer science, physics, general and organic chemistry, environmental science, physical chemistry, invertebrate zoology or paleontology, botany, zoology, ecology, physiology, geology, and statistics.

Each graduate student in the Department of Marine Sciences must gain a broad background in the marine sciences as well as an in-depth understanding of his or her own subdiscipline (e.g., chemical oceanography). This is accomplished by taking at least three of the four core courses (Marine Geology, Biological Oceanography, Chemical Oceanography, and Physical Oceanography: MASC 503,MASC 504, MASC 505, and MASC 506, respectively) and advanced courses determined by each student's advisory committee, and by participating in research that ultimately results in an M.S. thesis or a Ph.D. dissertation. By the end of the 24-month period that begins when a student first enrolls in the department, the student is expected to have completed the four core courses, How to Give a Seminar (MASC 705), and Student Interdisciplinary Seminar (MASC 706), and to have taken a written comprehensive exam (M.S. students) in his or her subdiscipline. Further information on degree requirements may be found at the department's Web site (http://marine.unc.edu/).

Doctor of Philosophy

The academic program for a Ph.D. student will be supervised by a faculty advisory committee of at least five members drawn from the UNC–Chapel Hill graduate faculty. Course requirements normally include at least three of the four core courses, additional advanced courses determined by the student's advisory committee, one hour of MASC 705, How to Give a Seminar, and one hour of MASC 706, Student Interdisciplinary Seminar. A waiver for one or more of the core courses can be arranged with the approval of the student's advisory committee and the Department of Marine Sciences Performance Committee. Additional requirements include passing a comprehensive examination containing both written (research proposal) and oral (proposal defense seminar) parts, a period of study or research at a marine station or participation on an oceanographic cruise, teaching experience sufficient to develop and demonstrate competence, and scientific research resulting in a written dissertation, which is defended by the student. More details on the Ph.D. comprehensive examination, admission to candidacy, semesters of residence credit, the dissertation, and final oral examination (the dissertation defense) are provided in the *Marine Sciences Graduate Student Handbook* and in *The Graduate School Handbook,* both available on the department's Web site (http://marine.unc.edu/).

Master of Science

The M.S. degree program is similar to the Ph.D. program except for the following: the advisory committee will be composed of three faculty members, the comprehensive examination is a written exam only, and scientific research will result in a written thesis, to be defended by the student. At least 30 hours of course credit must be earned prior to completing the M.S. degree program. Additional details on the comprehensive examination, admission to candidacy, semesters of residence credit, the thesis, and final oral examination (the thesis defense) are provided in the *Marine Sciences Graduate Student Handbook* and in *The Graduate School Handbook,* both available on the department's Web site (http://marine.unc.edu/).

Marine Sciences Core Courses

Code	Title	Hours
MASC 503	Marine Geology	4
MASC 504	Biological Oceanography	4
MASC 505	Chemical Oceanography	4
MASC 506	Physical Oceanography	4
Total Hours		16

Professors

Carol Arnosti, Marine Organic Geochemistry, Microbial Biogeochemistry
John M. Bane, Physical Oceanography and Meteorology, Gulf Stream and Upwelling Dynamics
Larry K. Benninger, Sedimentary Geochemistry
Jaye Cable, Groundwater Dynamics at the Land-Sea Interface, Biogeochemical Cycling, Wetland and Coastal Hydrology
Niels Lindquist, Chemical Ecology, Natural Products
Rick Luettich, Coastal Physical Oceanography, Modeling, Coastal Hazards
Christopher S. Martens, Marine Geochemistry
Brent A. McKee, Geochemistry/Geology of River-Ocean Environments, Sedimentary Geochemistry/Radiochemistry

Rachel Noble, Dynamics of Marine Microbial Food Webs
Hans W. Paerl, Microbial Ecology
Charles H. Peterson, Ecology, Population Interactions
Mike Piehler, Coastal Ecosystems and Estuarine Ecology
Antonio B. Rodriguez, Sedimentology, Marine and Coastal Geology
Harvey E. Seim, Observational Physical Oceanography, Coastal and Estuarine Dynamics
Alberto Scotti, Computational and Theoretical Fluid Dynamics, Environmental and Stratified Flows, Turbulence
Andreas Teske, Microbial Systematics and Evolution, Microbial Ecology, Microbiology of Hydrothermal Vents and the Marine Subsurface

Associate Professors

Marc J. Alperin, Chemical Oceanography, Biogeochemistry
Joel Fodrie, Fisheries Oceanography and Ecology, Restoration Ecology
Adrian Marchetti, Ecophysiology and Molecular Biology of Marine Phytoplankton
Brian L. White, Fluid Dynamics of Coastal Marine Systems, Hydrodynamics of Aquatic Vegetation, Gravity Currents, Shear Flows and Internal Waves

Assistant Professors

Karl D. Castillo, Marine Physiological Ecology, Climate Change and Coral Reefs
Scott Gifford, Physiology, Genomics and Systems Biology of Marine Bacteria, Bacterial Roles in the Marine Carbon Cycle
Alecia N. Septer, Marine Microbiology and Bacterial Interactions
Mei Wei,Tropical Cyclones and Climate Dynamics

Research Associate Professor

Johanna Rosman (UNC Institute of Marine Sciences), Physical Oceanography

Research Assistant Professors

Brett Froelich, Microbiology
Barbara MacGregor, Microbial Ecology

Faculty Emeriti

Dan Albert
Jan J. Kohlmeyer
A. Conrad Neumann

Adjunct Faculty

Frederick M. Bingham (UNC–Wilmington, Physics), Circulation and Water Mass Transportation
Carolyn Currin (National Oceanic and Atmospheric Administration), Coastal and Estuarine Ecology
Stephen R. Fegley (UNC Institute of Marine Sciences), Marine Biology/ Ecology
Jeffrey Hanson (U.S. Army Corps of Engineers Duck Field Research Facility), Dynamics of Surface Waves
Mandy Joye (University of Georgia), Biogeochemistry, Microbial Ecology, Molecular Biology
Wayne Litaker (National Oceanic and Atmospheric Administration), Ecology, Taxonomy and Molecular Biology of Harmful Algal Blooms
Kenneth J. Lohmann (Biology), Sea Turtle Navigation, Neuroethology of Sea Slug Orientation, Lobster Homing and Navigation
Stephen A. Skrabal (UNC–Wilmington, Chemistry), Trace Metal Geochemistry in Natural Waters
Jill Stewart (UNC Environmental Science and Engineering), Environmental Microbiology, Waterborne Pathogens
Pat Tester (National Oceanic and Atmospheric Administration), Oceanography and Ecology of Harmful Algal Blooms

MASC

Advanced Undergraduate and Graduate-level Courses

MASC 401. 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: BIOL 350, ENVR 417, GEOL 403.

MASC 410. Earth Processes in Environmental Systems. 4 Credits.
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.
Requisites: Prerequisites, CHEM 102, GEOL 200, MATH 231, and PHYS 115 or 119; permission of the instructor for students lacking the prerequisites.
Grading status: Letter grade
Same as: ENEC 410, GEOL 410.

MASC 411. Oceanic Processes in Environmental Systems. 4 Credits.
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.
Requisites: Prerequisites, BIOL 101, CHEM 102, ENEC 222, MATH 231, PHYS 115 or 119; permission of the instructor for students lacking the prerequisites.
Grading status: Letter grade
Same as: ENEC 411, GEOL 411.

MASC 415. Environmental Systems Modeling. 3 Credits.
This course explores principles and strategies for studying environmental phenomena, and presents methods for developing explanatory and predictive models of environmental systems, e.g., predator-prey, estuaries, greenhouse gases, and ecosystem material cycles.
Requisites: Prerequisite, MATH 383; pre- or corequisite, PHYS 115 or 118, and COMP 116.
Grading status: Letter grade
Same as: ENEC 415, GEOL 415.

MASC 432. Major World Rivers and Global Change: From Mountains to the Sea. 3 Credits.
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.
Grading status: Letter grade.

MASC 433. Wetland Hydrology. 3 Credits.
Study of wetland ecosystems with particular emphasis on hydrological functioning, the transition from terrestrial to aquatic systems, wetlands as filtration systems, and exchange between wetlands and other environments.
Grading status: Letter grade
Same as: ENEC 433.

MASC 434. Blue Carbon and Coastal Environments. 3 Credits.
Permission of the instructor is required. Readings and discussions about processes in traditional 'Blue Carbon' environments (marshes, sea grass beds, and mangroves) and an exploration of carbon burial in other coastal ecosystems such as floodplains and oyster reefs.
Grading status: Letter grade.

MASC 440. Marine Ecology. 3 Credits.
Survey of the ecological processes that structure marine communities in a range of coastal habitats. Course emphasizes experimental approaches to addressing basic and applied problems in marine systems.
Requisites: Prerequisite, BIOL 201 or 475.
Gen Ed: PL.
Grading status: Letter grade
Same as: BIOL 462.

MASC 441. Marine Physiological Ecology. 3 Credits.
This course introduces 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.
Grading status: Letter grade
Same as: ENEC 441.

MASC 442. Marine Biology. 3 Credits.
Recommended preparation, BIOL 201 or 475. 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.
Gen Ed: PL.
Grading status: Letter grade
Same as: BIOL 457.

MASC 443. Marine Microbiology. 3 Credits.
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.
Gen Ed: PL.
Grading status: Letter grade.

MASC 444. Marine Phytoplankton. 3 Credits.
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/practical session hours per week.
Grading status: Letter grade
Same as: ENEC 444, BIOL 456.

MASC 445. Marine Invertebrate Biology. 4 Credits.
See BIOL 475 for description.
Grading status: Letter grade.

MASC 446. Marine Microbial Symbioses: Exploring How Microbial Interactions Affect Ecosystems and Human Health. 3 Credits.
Course material covers host-microbe and microbe-microbe interactions found in marine ecosystems, including beneficial and parasitic relationships among viruses, microbes, marine animals, and humans. Limited to upper-level undergraduate science majors and graduate students.
Gen Ed: PL.
Grading status: Letter grade
Same as: BIOL 452.

MASC 447. Microbial Ecological Genomics. 3 Credits.
Permission of the instructor. For junior and senior science majors and graduate students. Active learning class focused on sequencing and bioinformatic analysis of microbial genomes to identify their ecological function. Topics include sequencing technologies, genome assembly and analysis, command line, bioinformatic tools, and genes mediating microbial physiology and metabolism in natural ecosystems.
Gen Ed: PL.
Grading status: Letter grade.

MASC 448. Coastal and Estuarine Ecology. 4 Credits.
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 two credit hours to the course.
Requisites: Prerequisites, CHEM 102 and MATH 231.
Grading status: Letter grade
Same as: ENEC 448.

MASC 450. Biogeochemical Processes. 4 Credits.
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. Three lecture hours and one laboratory hour a week.
Requisites: Prerequisites, MATH 231, and PHYS 114 or 118; permission of the instructor for students lacking the prerequisites.
Gen Ed: PL.
Grading status: Letter grade
Same as: ENEC 450, GEOL 450.

MASC 455. Geochemistry. 3 Credits.
Required preparation, one introductory geology course. Introduction to the application of chemical principles to geological problems. Topics include thermodynamics, kinetics, and isotope geochemistry. Previously offered as GEOL 512/MASC 553.
Requisites: Prerequisites, CHEM 102 and MATH 231; permission of the instructor for students lacking the prerequisites.
Gen Ed: QI.
Grading status: Letter grade
Same as: GEOL 405.

MASC 460. Fluid Dynamics of the Environment. 3 Credits.
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.
Requisites: Prerequisite, MATH 232; permission of the instructor for students lacking the prerequisite.
Gen Ed: QI.
Grading status: Letter grade.

MASC 470. Estuarine and Coastal Marine Science. 4 Credits.
For graduate students; undergraduate students should take ENEC 222 or have permission of the instructor. Introduction to estuarine environments: geomorphology, physical circulation, nutrient loading, primary and secondary production, carbon and nitrogen cycling, benthic processes and sedimentation. Considers human impacts on coastal systems, emphasizing North Carolina estuaries.
Gen Ed: PL, QI.
Grading status: Letter grade.

MASC 471. Human Impacts on Estuarine Ecosystems. 4 Credits.
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. Taught at off-campus field station.
Requisites: Prerequisites, CHEM 102 and MATH 231.
Gen Ed: EE- Field Work.
Grading status: Letter grade
Same as: ENEC 471.

MASC 472. Barrier Island Ecology and Geology. 6 Credits.
Recommended preparation, one introductory geology course. 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.
Gen Ed: PL, EE- Field Work.
Grading status: Letter grade.

MASC 473. The Changing Coasts of Carolina. 3 Credits.
A rigorous combination of field work, lab work, and colorful, original contemporary writing on the natural world will help tell the story of our many, evolving North Carolina coasts. Combining marine science and the creative literary arts, this immersive course will explore issues of change over many eras. This combination of social, cultural, and scientific observation will lead to imaginatively constructed, well-written non-fiction reportage about one of North America's most productive, compelling, and challenging regions.
Gen Ed: CI, EE- Field Work.
Grading status: Letter grade
Same as: ENGL 473.

MASC 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: GEOL 480, ENVR 480.

MASC 483. Geologic and Oceanographic Applications of Geographical Information Systems. 4 Credits.
Required preparation, four GEOL courses or permission of the instructor. Focus is 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. Three lecture and two laboratory hours a week.
Grading status: Letter grade
Same as: GEOL 483.

MASC 490. Special Topics in Marine Sciences for Undergraduates and Graduates. 1-3 Credits.
Directed readings, laboratory, and/or field study of marine science topics not covered in scheduled courses.
Repeat rules: May be repeated for credit. 12 total credits. 4 total completions.
Grading status: Letter grade.

MASC 503. Marine Geology. 4 Credits.
For graduate students; undergraduates need permission of the instructor. Investigates formation of the oceans, plate tectonics, carbonate reefs and platforms, sediment transport from the land to deep-sea fans, glacial-marine geology, marine records of changes in sea level and climate, and the evolution of barrier islands, estuaries, and deltas. Mandatory weekend field trip to the Southern Outer Banks.
Gen Ed: PL.
Grading status: Letter grade
Same as: GEOL 503.

MASC 504. 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: BIOL 657, ENVR 520.

MASC 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: ENVR 505, GEOL 505.

MASC 506. Physical Oceanography. 4 Credits.
For graduate students; undergraduates need permission of the instructor. Descriptive oceanography, large-scale wind-driven and thermohaline circulations, ocean dynamics, regional and nearshore/estuarine physical processes, waves, tides. Three lecture and one recitation hour per week.
Gen Ed: PL.
Grading status: Letter grade
Same as: GEOL 506.

MASC 550. Biogeochemical Cycling. 3 Credits.
Biogeochemical cycling explores interfaces of marine, aquatic, atmospheric, and geological sciences emphasizing processes controlling chemical distributions in sediments, fresh and salt water, the atmosphere, and fluxes among these reservoirs.
Requisites: Prerequisites, ENVR 421; GEOL 405, 436, 655; MASC 440, 505; or permission of the instructor.
Gen Ed: PL, CI.
Grading status: Letter grade
Same as: GEOL 550.

MASC 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: GEOL 552, ENVR 552.

MASC 560. 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: ENVR 452, GEOL 560, PHYS 660.

MASC 561. Time Series and Spatial Data Analysis. 3 Credits.
Three components: statistics and probability, time series analysis, and spatial data analysis. Harmonic analysis, nonparametric spectral estimation, filtering, objective analysis, empirical orthogonal functions.
Requisites: Prerequisite, MATH 233; permission of the instructor for students lacking the prerequisite.
Gen Ed: PL, QI.
Grading status: Letter grade.

MASC 562. Turbulent Boundary Layers. 3 Credits.
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.
Requisites: Prerequisite, MASC 506 or 560; permission of the instructor for students lacking the prerequisite.
Gen Ed: PL, QI.
Grading status: Letter grade.

MASC 563. Descriptive Physical Oceanography. 3 Credits.
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.
Requisites: Prerequisite, MASC 506; permission of the instructor for students lacking the prerequisite.
Gen Ed: PL.
Grading status: Letter grade
Same as: GEOL 563.

Graduate-level Courses

MASC 705. How to Give a Seminar. 1 Credit.
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.
Grading status: Letter grade.

MASC 706. Student Interdisciplinary Seminar. 1 Credit.
Marine Sciences graduate students will prepare and present a seminar on an interdisciplinary topic from contemporary research in marine systems.
Requisites: Prerequisite, MASC 705.
Grading status: Letter grade.

MASC 730. Advanced Coastal Environmental Change. 3 Credits.
Focuses on biological-physical couplings that shape coastal environments (i.e. coastal 'ecomorphodynamics') and determine how these environments change with climate and land use. Environments include: barrier islands, open ocean coastlines, and tidal wetlands. Grading based on presentations, participation, and a research proposal.
Requisites: Prerequisites, GEOL 417, 502, or 503; permission of the instructor for students lacking the prerequisites.
Grading status: Letter grade
Same as: GEOL 710, ENEC 710.

MASC 741. Seminar in Marine Biology. 2 Credits.
Discussion of selected literature in the field of marine biology, ecology, and evolution.
Grading status: Letter grade.

MASC 742. Molecular Population Biology. 4 Credits.
Hands-on training, experience, and discussion of the application of molecular genetic tools to questions of ecology, evolution, systematics, and conservation.
Requisites: Prerequisite, BIOL 471; Permission of the instructor for students lacking the prerequisites.
Grading status: Letter grade
Same as: BIOL 758.

MASC 750. Modeling Diagenetic Processes. 3 Credits.
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.
Requisites: Prerequisite, MASC 480; Permission of the instructor for students lacking the prerequisite.
Grading status: Letter grade.

MASC 761. Geophysical Fluid Dynamics. 3 Credits.
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.
Requisites: Prerequisite, MASC 560 or MATH 528; permission of the instructor for students lacking the prerequisite.
Grading status: Letter grade.

MASC 762. Ocean Circulation Theory. 3 Credits.
Theories, models of large-scale dynamics of ocean circulation. Potential vorticity, quasi-geostrophy, instabilities.
Requisites: Prerequisite, MASC 506 or 560, or MATH 529; permission of the instructor for students lacking the prerequisite.
Grading status: Letter grade.

MASC 763. Coastal Circulation. 3 Credits.
Dynamics of the coastal ocean. Shallow water equations, boundary layer and long wave theory, wind driven circulation, fronts, estuaries.
Requisites: Prerequisite, MASC 506 or 560, or MATH 529; permission of the instructor for students lacking the prerequisite.
Grading status: Letter grade.

MASC 764. Ocean Circulation Modeling. 3 Credits.
Computational methods used in modeling oceanic circulation. Numerical solution of equations governing mass, momentum, and energy equations.
Requisites: Prerequisite, MASC 506 or MATH 529; permission of the instructor for students lacking the prerequisite.
Grading status: Letter grade.

MASC 765. Small-Scale Physics of the Ocean. 3 Credits.
Physics of sub-mesoscale processes in the ocean. Nonequilibrium thermodynamics. Air-sea interaction. Mixing in the ocean boundary layer, convection, double diffusion. Near-inertial and high frequency internal waves. Three lecture hours a week.
Requisites: Prerequisites, MASC 506 and 560.
Grading status: Letter grade.

MASC 781. Numerical ODE/PDE, I. 3 Credits.
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.
Requisites: Prerequisites, MATH 661 and 662.
Grading status: Letter grade
Same as: MATH 761, ENVR 761.

MASC 782. Numerical ODE/PDE, II. 3 Credits.
Elliptic equation methods (finite differences, elements, integral equations); hyperbolic conservation law methods (Lax-Fiedrich, characteristics, entropy condition, shock tracking/capturing); spectral, pseudo-spectral methods; particle methods, fast summation, fast multipole/vortex methods.
Requisites: Prerequisite, MATH 761.
Grading status: Letter grade
Same as: MATH 762, ENVR 762.

MASC 783. Mathematical Modeling I. 3 Credits.
Nondimensionalization and identification of leading order physical effects with respect to relevant scales and phenomena; derivation of classical models of fluid mechanics (lubrication, slender filament, thin films, Stokes flow); derivation of weakly nonlinear envelope equations. Fall.
Requisites: Prerequisites, MATH 661, 662, 668, and 669.
Grading status: Letter grade
Same as: MATH 768, ENVR 763.

MASC 784. Mathematical Modeling II. 3 Credits.
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).
Requisites: Prerequisites, MATH 661, 662, 668, and 669.
Grading status: Letter grade
Same as: MATH 769, ENVR 764.

MASC 799. Experimental Graduate. 1-9 Credits.
Experimental graduate level courses as offered by the Department.
Repeat rules: May be repeated for credit; may be repeated in the same term for different topics; 9 total credits. 1 total completions.
Grading status: Letter grade.

MASC 893. Special Topics in Marine Geology. 1-9 Credits.
Special topics courses in Marine Geology as offered by Department.
Repeat rules: May be repeated for credit; may be repeated in the same term for different topics; 9 total credits. 1 total completions.
Grading status: Letter grade.

MASC 894. Special Topics in Biological Oceanography. 1-9 Credits.
Special topics courses in Biological Oceanography as offered by Department.
Repeat rules: May be repeated for credit; may be repeated in the same term for different topics; 9 total credits. 1 total completions.
Grading status: Letter grade.

MASC 895. Special Topics in Physical Oceanography. 1-9 Credits.
Special topics courses in Physical Oceanography as offered by Department.
Repeat rules: May be repeated for credit; may be repeated in the same term for different topics; 9 total credits. 1 total completions.
Grading status: Letter grade.

MASC 896. Special Topics in Chemical Oceanography. 1-9 Credits.
Special topics courses in Chemical Oceanography as offered by Department.
Repeat rules: May be repeated for credit; may be repeated in the same term for different topics; 9 total credits. 1 total completions.
Grading status: Letter grade.

MASC 897. Special Topics in Marine Sciences. 1-9 Credits.
Special topics courses in Marine Sciences as offered by Department.
Repeat rules: May be repeated for credit; may be repeated in the same term for different topics; 9 total credits. 1 total completions.
Grading status: Letter grade.

MASC 940. Research in Marine Sciences. 2-21 Credits.

MASC 993. Master's Research and Thesis. 3 Credits.

MASC 994. Doctoral Research and Dissertation. 3 Credits.