

DEPARTMENT OF EARTH, MARINE, AND ENVIRONMENTAL SCIENCES (GRAD)

The Department of Earth, Marine and Environmental Sciences (EMES) advances understanding of the earth and ocean processes that govern our planet, shape diverse ecosystems, sustain life, and drive environmental change. We promote exploration and discovery of the natural world by engaging students in research-based learning at all levels. Our graduates are equipped with the strong science foundation, critical thinking skills, and interdisciplinary perspectives required to tackle current and future environmental and resource challenges. We encourage engaged service that translates knowledge for the public good. We support a welcoming and inclusive environment, foster diverse identities and perspectives, and encourage collaboration with all segments of society.

Facilities

The primary location of our department in Chapel Hill fosters interactions with faculty, students, and staff from other UNC–Chapel Hill departments, nearby research institutions and companies; places scientists within easy reach of RDU International Airport, allowing for the convenient transport of equipment and personnel to distant ports and field locations; and provides ready access to advanced computational resources through RENCi (Renaissance Computing Institute). The department's marine laboratory, the Institute of Marine Sciences (<https://emes.unc.edu/institute-of-marine-sciences/>) in Morehead City, provides coastal access for field studies and instruction. Shared, flexible laboratory space is also now available at the Institute since the addition of a new wing.

The department maintains research facilities and office space in both Murray-Venable Hall and Elisha Mitchell Hall. Specialized analytical equipment and facilities supporting marine science include low background alpha, beta, and gamma detectors, a dedicated GC/MS system, a state-of-the-art isotope ratio monitoring mass spectrometry facility for compound specific carbon analyses, high capacity light- and temperature-controlled incubators, and a full range of specialized chromatographic and spectroscopic gear. Observational instrumentation for field use includes a suite of current meters and temperature/pressure sensors, near-bottom and sub-bottom water samplers and profilers, and a specially built a sensor and data system for aircraft sampling of the coastal ocean and atmosphere.

Geological instrumentation includes two thermal ionization mass spectrometers with associated Class 100 clean labs; quadrupole ICPMS; a sediment analysis laboratory including refrigerated core storage; a laser-size particle analyzer; X-ray fluorescence spectrometer; X-ray diffractometer; scanning electron microscope with X-ray analysis and cathodoluminescence; counting laboratory (alpha-, beta-, and gamma-emitting radionuclides); experimental petrology laboratory. Access to a field-emission electron microprobe is also available through a remotely operated system at Fayetteville State University.

Geological Sciences

The department offers programs leading to the M.S. and Ph.D. degrees in geological sciences. A broad background is offered in most major areas

of geoscience, with particular emphasis on global hydrology, flooding and fluvial hydrology, coastal processes and geomorphology, isotope geochemistry and geochronology, seismology, volcanology, igneous and metamorphic petrology, low-temperature geochemistry, paleoclimatology and paleoecology, structural geology and tectonics, surface processes, and tectonic geomorphology.

Admission and General Degree Requirements

Students admitted to pursue a graduate degree in the department are typically expected to have an undergraduate degree in traditional geology, geochemistry, geophysics, biology, chemistry, mathematics, physics, or other related interdisciplinary fields. Please note that the Graduate Record Examination (GRE) is no longer required of applicants. All foreign students whose native language is not English also must take the Test of English as a Foreign Language (TOEFL) examination.

Course requirements for incoming students will be determined by individual graduate committees, often in consultation with the director of graduate studies. Specific requirements are varied to meet the needs and career objectives of the individual.

Financial Aid

The department typically supports 10–12 graduate students in geological sciences with teaching assistantships during the 9-month academic year with stipends of ~\$18000. In addition, all graduate students are eligible to apply for departmental summer fellowships (\$7,000), research funds, and conference funds from a departmental endowment.

The department also nominates up to three students for consideration by The Graduate School for graduate fellowships; no additional application is necessary. Faculty research grants support some research assistantships. Out-of-state students are recommended for remission of out-of-state tuition costs; all students are recommended for an in-state tuition award. Most students are eligible for both and therefore are responsible only for the payment of student fees. Further information may be found on the department's website (<http://marine.unc.edu/>).

Master of Science

Requirements for the master of science degree are 30 semester hours (including a minimum of three hours, but no more than six hours of GEOL 993), a thesis, and a final oral examination in defense of the thesis.

Doctor of Philosophy

Many students have completed a master's degree before being admitted to the doctoral program, but some students enter the Ph.D. program having completed only an undergraduate degree. Students admitted to the M.S. program who elect to pursue a Ph.D. instead may be permitted to bypass the master's degree after one semester of residence upon demonstration of superior scholastic performance and research potential. Recommendation by the student's graduate committee and approval by the geological sciences faculty is required in this case.

Admission to the Ph.D. program after completing the M.S. degree in the Department of Geological Sciences requires faculty approval.

Requirements for the Ph.D. degree are a minimum of 48 semester hours of graduate credit (which may include 30 hours from the M.S. degree) and a minimum of six hours and preferably no more than 12 hours of GEOL 994, a written comprehensive examination and an oral comprehensive examination, a dissertation, and a final oral examination in defense of the dissertation.

Marine Sciences

The department provides teaching and research in estuarine, coastal, and oceanographic sciences leading to M.S. and Ph.D. degrees in marine sciences. 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.

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.

Admission Requirements

For admission to the department, 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 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 (listed below) 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 website (<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 website (<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 and one hour of MASC 706. 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's 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 website (<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
Jaye Cable, Groundwater Dynamics at the Land-Sea Interface, Biogeochemical Cycling, Wetland and Coastal Hydrology
Drew S. Coleman, Isotope Geochemistry, Geochronology
Joel Fodrie, Fisheries Oceanography and Ecology, Restoration Ecology
Eric Kirby, Active Tectonics, Landscape Evolution, Tectonic Geomorphology
Jonathan M. Lees, Seismology, Volcanology
Niels Lindquist, Chemical Ecology, Natural Products
Richard Luettich, Coastal Physical Oceanography, Modeling, Coastal Hazards
Christopher S. Martens, Marine Geochemistry
Brent A. McKee, Geochemistry/Geology of River-Ocean Environments, Sedimentary Geochemistry/Radiochemistry
Laura J. Moore, Coastal Geology
Rachel Noble, Dynamics of Marine Microbial Food Webs
Janet Nye, Quantitative Fisheries Ecology
Hans W. Paerl, Microbial Ecology
Tamlin M. Pavelsky, Global Hydrology
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
Donna M. Surge, Paleoclimate, Paleoecology, Low-Temperature Geochemistry
Andreas Teske, Microbial Systematics and Evolution, Microbial Ecology, Microbiology of Hydrothermal Vents and the Marine Subsurface

Associate Professors

Marc J. Alperin, Chemical Oceanography, Biogeochemistry
Karl D. Castillo, Marine Physiological Ecology, Climate Change and Coral Reefs
Scott Gifford, Microbial Ecology and Biogeochemistry
Xiaoming Liu, Geochemistry
Adrian Marchetti, Ecophysiology and Molecular Biology of Marine Phytoplankton

Johanna Rosman, Coastal and Estuarine Fluid Dynamics
Alecia N. Septer, Microbiology
Kevin G. Stewart, Structural Geology
Brian L. White, Fluid Dynamics of Coastal Marine Systems, Hydrodynamics of Aquatic Vegetation, Gravity Currents, Shear Flows and Internal Waves

Assistant Professors

Kennet E. Flores, Petrologic and Tectonic Processes
Wei Mei, Tropical Cyclones and Climate Dynamics
Antonia Sebastian, Applied Hydrology and Water Resources

Research Professor

Michael J. Shore, Geophysics and Seismology

Research Assistant Professors

Nathan Hall
Ryan Mills, Geochemistry
Xiao Yang, Global Hydrology, Remote Sensing, Big Data Analytics

Professors Emeriti

Dan Albert, Larry K. Benninger, Joseph G. Carter, Paul Fullagar, Allen F. Glazner, Jan J. Kohlmeier, A. Conrad Neumann, Daniel A. Textoris.

Assistant Teaching Professors

Michelle Haskin, Geoscience Education
Megan F. Plenge, Geoscience Education

GEOL

Advanced Undergraduate and Graduate-level Courses

GEOL 403. 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.

Rules & Requirements

Grading Status: Letter grade.

Same as: MASC 401, BIOL 350, ENVR 417.

GEOL 405. 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.

Rules & Requirements

Making Connections Gen Ed: QI.

Requisites: Prerequisites, CHEM 102 and MATH 231; permission of the instructor for students lacking the prerequisites.

Grading Status: Letter grade.

Same as: MASC 455.

GEOL 406. Introduction to Geophysics. 3 Credits.

Introduction to the fundamentals of global geophysics: gravity, seismology, magnetism, heat, and plate tectonics. Both shallow and deep processes are considered. Emphasis is aimed at problem solving by applying concepts. Previously offered as GEOL 515.

Rules & Requirements

Requisites: Prerequisites, PHYS 114, 116, or 118, and 115, 117, or 119.

Grading Status: Letter grade.

GEOL 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.

Rules & Requirements

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, MASC 410.

GEOL 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.

Rules & Requirements

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, MASC 411.

GEOL 412. Principles and Methods of Teaching Earth Science. 4 Credits.

Required preparation, any introductory geology course. This course develops the knowledge and skills teachers need to implement inquiry-based earth science instruction: conceptual knowledge of earth sciences and mastery of inquiry instructional methods. Students study inquiry in cognitive science and learning theory. This course is a requirement for the UNC-BEST program in geological sciences.

Rules & Requirements

 **IDEAs in Action Gen Ed:** HI-SERVICE.

Making Connections Gen Ed: EE- Service Learning.

Grading Status: Letter grade.

Same as: ENEC 412.

GEOL 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.

Rules & Requirements

Requisites: Prerequisite, MATH 383; pre- or corequisite, PHYS 115 or 118, and COMP 116.

Grading Status: Letter grade.

Same as: ENEC 415, MASC 415.

GEOL 417. Surface Processes and Landscape Evolution. 3 Credits.

Earth surface processes and landscape evolution.

Rules & Requirements

Requisites: Prerequisites, GEOL 201 and MATH 231; permission of the instructor for students lacking the prerequisites.

Grading Status: Letter grade.

Same as: ENEC 417.

GEOL 417L. Geomorphology Laboratory. 1 Credits.

Two laboratory hours per week.

Rules & Requirements

Requisites: Pre- or corequisite, GEOL 417.

Grading Status: Letter grade.

GEOL 421. Archaeological Geology. 3 Credits.

Permission of the instructor. The application of geological principles and techniques to the solution of archaeological problems. Studies geological processes and deposits pertinent to archaeological sites, geologic framework of archaeology in the southeastern United States, and techniques of archaeological geology. Field trips to three or more sites; written reports required.

Rules & Requirements

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.

Same as: ANTH 421.

GEOL 422. Physics of the Earth's Interior. 3 Credits.

Origin of the solar system: the nebular hypothesis. Evolution of the earth and its accretionary history. Earthquakes: plate tectonics and the interior of the earth. The earth's magnetic field. Mantle convection.

Rules & Requirements

Requisites: Prerequisites, MATH 383, and either PHYS 201 and 211 or 311 and 401.

Grading Status: Letter grade.

Same as: PHYS 422.

GEOL 425. Introduction to Field Geology. 3 Credits.

Introduction to geologic field methods. Includes making observations, mapping, identification of structures and features, and interpretation to solve basic geologic problems. Many field trips. Previously offered as GEOL 225.

Rules & Requirements

Making Connections Gen Ed: EE- Field Work.

Requisites: Prerequisites, GEOL 302, 303, and 304; permission of the instructor for students lacking the prerequisites.

Grading Status: Letter grade.

GEOL 432. Paleoclimatology. 3 Credits.

Introduction to mechanisms that drive climate. Examination of past climate reconstructions using ecological and geochemical proxies. Utility of computer models to reconstruct past climates and predict future climate change. Emphasis placed on late Quaternary.

Rules & Requirements

Requisites: Prerequisite, GEOL 202 or 303; permission of the instructor for students lacking the prerequisite.

Grading Status: Letter grade.

GEOL 433. Paleocceanography. 3 Credits.

Origin and distribution of pelagic sediments. Review of the major Mesozoic and Cenozoic events in the world oceans. Glacial/interglacial changes in the ocean/atmosphere system.

Rules & Requirements

Requisites: Prerequisite, GEOL 303 or 503; permission of the instructor for students lacking the prerequisite.

Grading Status: Letter grade.

GEOL 435. Groundwater. 3 Credits.

Required preparation, one introductory geology course. Introduction to physics, chemistry, and geology of groundwater. Previously offered as GEOL 509.

Rules & Requirements

Making Connections Gen Ed: QI.

Requisites: Prerequisite, GEOL 201; CHEM 102; MATH 231; PHYS 104 or 114 or 116 or 118; permission of the instructor for students lacking the prerequisites.

Grading Status: Letter grade.

Same as: ENEC 435.

GEOL 436. Geochemistry of Natural Waters. 3 Credits.

Required preparation, one introductory geology course. Survey of processes affecting the compositions of streams, lakes, the ocean, and shallow ground waters. Previously offered as GEOL 510.

Rules & Requirements

Making Connections Gen Ed: QI.

Requisites: Prerequisites, CHEM 102 and MATH 231; permission of the instructor for students lacking the prerequisites.

Grading Status: Letter grade.

GEOL 440. Principles of Seismology. 3 Credits.

Descriptive account of global seismology, earthquake distribution, and focal mechanics. Principles of geometrical optics and applications to imaging the earth's interior. Principles of seismic prospecting of hydrocarbon and geothermal reservoirs.

Rules & Requirements

Requisites: Prerequisites, GEOL 200, 302; MATH 231; permission of the instructor for students lacking the prerequisites.

Grading Status: Letter grade.

GEOL 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.

Rules & Requirements

Making Connections Gen Ed: PL.

Requisites: Prerequisites, MATH 231, and PHYS 114 or 118; permission of the instructor for students lacking the prerequisites.

Grading Status: Letter grade.

Same as: ENEC 450, MASC 450.

GEOL 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.

Rules & Requirements

Making Connections Gen Ed: QI.

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

Grading Status: Letter grade.

GEOL 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.

Rules & Requirements

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

Grading Status: Letter grade.

Same as: MASC 480, ENVR 480.

GEOL 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.

Rules & Requirements

Grading Status: Letter grade.

Same as: MASC 483.

GEOL 485. Summer Field Course in Geology. 3 Credits.

Three-week field camp conducted in the western United States (Arizona, California, Colorado, Nevada, New Mexico, and/or Utah). Learn proper use of geology field tools and how to make a geologic map. Field interpretation of rocks and their deformation. Previously offered as GEOL 601.

Rules & Requirements

Making Connections Gen Ed: EE- Field Work.

Requisites: Prerequisites, GEOL 302, 303, and 304; permission of the instructor for students lacking the prerequisites.

Grading Status: Letter grade.

GEOL 486. Summer Field Course in Geology. 3 Credits.

Three-week field camp conducted in the western United States (Arizona, California, Colorado, Nevada, New Mexico, and/or Utah). Learn advanced mapping skills necessary to interpret geologic history of complexly deformed rocks. Previously offered as GEOL 602.

Rules & Requirements

Making Connections Gen Ed: EE- Field Work.

Requisites: Prerequisites, GEOL 302, 303, and 304; permission of the instructor for students lacking the prerequisites.

Grading Status: Letter grade.

GEOL 490. Topics in Earth and Environmental Sciences. 3 Credits.

Key topics and resources for high school teachers preparing to teach earth and environmental sciences. Includes lithosphere, tectonic processes, hydrosphere, atmosphere, origin of solar system and life, and environmental stewardship.

Rules & Requirements

Grading Status: Letter grade.

GEOL 501. Geological Research Techniques. 3 Credits.

Permission of the instructor. Theory and practice of analytical methods in geochemistry including X-ray diffraction, X-ray fluorescence, and scanning electron microscopy; introduction to electronics.

Rules & Requirements

Grading Status: Letter grade.

GEOL 502. Earth Surface Processes. 3 Credits.

This course will focus on the processes of soil formation, erosion, and landform evolution with an emphasis on the interaction of geomorphic processes with surface hydrology and ecosystems. (EES)

Rules & Requirements

Making Connections Gen Ed: PL.

Requisites: Prerequisite, GEOG 110.

Grading Status: Letter grade.

Same as: GEOG 440.

GEOL 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.

Rules & Requirements

Making Connections Gen Ed: PL.

Grading Status: Letter grade.

Same as: MASC 503.

GEOL 504. Advanced Petrology. 3 Credits.

Origin of magmas and evolution of igneous and metamorphic rocks, combined with petrographic study of selected sites.

Rules & Requirements

Requisites: Prerequisite, GEOL 304.

Grading Status: Letter grade.

GEOL 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.

Rules & Requirements

Making Connections Gen Ed: PL.

Grading Status: Letter grade.

Same as: MASC 505, ENVR 505.

GEOL 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.

Rules & Requirements

Making Connections Gen Ed: PL.

Grading Status: Letter grade.

Same as: MASC 506.

GEOL 508. Global Hydrology. 3 Credits.

An introduction to methodologies and instrumentation for quantifying the movement of water in the earth system focusing on components of the hydrologic cycle.

Rules & Requirements

Requisites: Prerequisites, GEOL/ENEC 324 and MATH 231; permission of the instructor for students lacking the prerequisites.

Grading Status: Letter grade.

GEOL 511. Stable Isotopes in the Environment. 3 Credits.

Introduction to the theory, methods, and applications of stable isotopes to environmental problems. Primary focus will be on the origin, natural abundance, and fractionation of carbon, hydrogen, oxygen, and nitrogen isotopes.

Rules & Requirements

Requisites: Prerequisite, CHEM 102.

Grading Status: Letter grade.

Same as: ENEC 511.

GEOL 514. Rivers and Floods. 3 Credits.

River floods are critically important in the global hydrologic cycle. While seasonal floods can be environmentally restorative, they can also have devastating socio-economic and public health consequences. Beginning with the hydrologic cycle, this course will cover concepts related to rainfall runoff and hydrologic response, flood frequency analysis, the mechanics of open channel flow, and overland and channel routing. Students will also gain experience working with real-world data and engineering software.

Rules & Requirements

Requisites: Prerequisites, GEOL 201 and MATH 231; or permission of instructor.

Grading Status: Letter grade.

Same as: ENEC 514.

GEOL 517. Sequence and Seismic Stratigraphy. 3 Credits.

Examination of lithostratigraphic principles and the sequence stratigraphic paradigm. Students will study use of variation of well log signature reflection attributes and reflection termination patterns to identify and correlate sequences and systems and to interpret the lithology and depositional history of subsurface stratigraphic units.

Rules & Requirements

Requisites: Prerequisite, GEOL 303.

Grading Status: Letter grade.

GEOL 518. Geodynamics. 3 Credits.

Required preparation, one introductory geology course. Interior of the earth deduced from seismology, gravity, heat flow, magnetism; geophysics of continents and ocean basins; age of earth.

Rules & Requirements

Requisites: Prerequisites, CHEM 102; MATH 232; and PHYS 104 and 105, or 114 and 115.

Grading Status: Letter grade.

GEOL 520. Data Analysis in the Earth Sciences. 3 Credits.

Required preparation, an introductory geology course numbered below 202, except first-year seminar, or permission of the instructor. Introduction to quantitative analysis in earth sciences: solid earth, atmospheres, oceans, geochemistry, and paleontology. Topics covered: univariate and multivariate statistics, testing, nonparametric methods, time series, spatial and cluster analysis, shapes.

Rules & Requirements

Requisites: Prerequisites, MATH 231 and 232.

Grading Status: Letter grade.

GEOL 521. Clastic Depositional Systems: Processes and Products. 3 Credits.

Examination of the use of lateral and vertical changes in sedimentary facies to identify depositional processes and environments of deposition within the terrestrial, marginal marine, shelf, and deep sea clastic depositional systems. These systems will be examined in a sequence stratigraphic framework.

Rules & Requirements

Requisites: Prerequisite, GEOL 303.

GEOL 522. Physical Volcanology. 3 Credits.

Required preparation, introductory courses in geology and physics. Course is aimed at understanding the physical properties and processes controlling volcanism and magma transport. Topics covered include volcanic processes from the formation of magma in the upper mantle to violent eruption at the surface. Emphasizes dynamic processes and underlying mechanisms.

Rules & Requirements

Grading Status: Letter grade.

GEOL 523. Petroleum Geoscience. 4 Credits.

Students study the origin, migration, and entrapment of hydrocarbons in sedimentary basins and learn how several areas of the geosciences are integrated to locate and produce hydrocarbons. Students learn about these topics while analyzing a real subsurface data set.

Rules & Requirements

Requisites: Prerequisites, GEOL 302 and 303; permission of the instructor for students lacking the prerequisites.

Grading Status: Letter grade.

GEOL 525. Inverse Theory: Advanced Data Analysis and Geophysical Modeling. 3 Credits.

The course deals with earth science problems related to extracting model parameters from data and field observations. Details of mathematical concepts, real world examples, and practical applications associated with noisy or incomplete data are covered. Key concepts include multivariate regression, model discretization, Tikhonov regularization, and Bayesian methods.

Rules & Requirements

Grading Status: Letter grade.

GEOL 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.

Rules & Requirements

Making Connections Gen Ed: PL, CI.

Requisites: Prerequisites, ENVR 421; GEOL 405, 436, 655; MASC 440, 505; or permission of the instructor.

Grading Status: Letter grade.

Same as: MASC 550.

GEOL 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.

Rules & Requirements

Making Connections Gen Ed: PL.

Grading Status: Letter grade.

Same as: MASC 552, ENVR 552.

GEOL 555. Paleobotany: An Introduction to the Past History of Plants. 3 Credits.

An introduction to the fossil record of plants, investigating how plants originated and changed through geological time to produce the modern flora. Both macrofossils and microfossils will be considered. Three lecture hours a week.

Rules & Requirements

Making Connections Gen Ed: EE- Field Work.

Requisites: Prerequisites, BIOL 202, and one other BIOL course above 200; corequisite, BIOL 555L; permission of the instructor for students lacking the requisites.

Grading Status: Letter grade.

Same as: BIOL 555.

GEOL 560. Fluid Dynamics. 3 Credits.

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

Rules & Requirements

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

Grading Status: Letter grade.

Same as: MASC 560, ENVR 452, PHYS 660.

GEOL 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.

Rules & Requirements

Making Connections Gen Ed: PL.

Requisites: Prerequisite, MASC 506; permission of the instructor for students lacking the prerequisite.

Grading Status: Letter grade.

Same as: MASC 563.

GEOL 567. Application of Plasma Mass Spectrometry in Earth and Environmental Sciences. 3 Credits.

This class is an introduction to one of the state-of-the-art analytical techniques in geological and environmental research - the ICP-MS (Inductively Coupled Plasma - Mass Spectrometry). Students will have hands-on experiences with ICP-MS sample preparation and analysis, and they will design their own hypothesis-driven research projects to analyze major and trace elements in geological and environmental samples including water, rock, and soil.

Rules & Requirements

Making Connections Gen Ed: EE- Mentored Research.

Requisites: Prerequisite, GEOL 101, 200, or 201.

Grading Status: Letter grade.

GEOL 580. Evolution of Earth's Surface Environment. 3 Credits.

The course combines geology, climatology, hydrology, and soil science to explore the evolution of the surface environment of the earth from the Archean to the present, including the great oxidation event and modern ocean anoxia. Students will read research papers and will be encouraged to question and debate course topics.

Rules & Requirements

Grading Status: Letter grade.

GEOL 590. Special Topics in Earth Sciences. 1-4 Credits.

Discussion or lab-based consideration of topical issues in earth sciences.

Rules & Requirements

Repeat Rules: May be repeated for credit; may be repeated in the same term for different topics; 8 total credits. 2 total completions.

Grading Status: Letter grade.

GEOL 595. Advanced Field Seminar in Geology. 1-4 Credits.

A field course that emphasizes advanced field methods. Emphasis is placed on large-scale, detailed field work in complex structural terrains and on independent mapping that will lead to thesis/dissertation and/or publication. Previously offered as GEOL 695.

Rules & Requirements

Requisites: Prerequisites, GEOL 485 and 486.

Grading Status: Letter grade.

GEOL 608. Continuum Mechanics in the Earth Sciences. 3 Credits.

Applications of continuum mechanics in the earth sciences, including stress, strain, elasticity, and viscous flow. Numerical solutions to problems in heterogeneous finite strain including finite element analysis.

Rules & Requirements

Requisites: Prerequisites, GEOL 302, and PHYS 114, 116, or 118.

Grading Status: Letter grade.

Same as: ENEC 608.

GEOL 655. Recent Advances in Non-Traditional Stable Isotope Geochemistry. 3 Credits.

This seminar will introduce students to state of the art analytical techniques, current theories, and their applications in various geological processes regarding the non-traditional stable isotopes (e.g., Li, Mg, Fe, Mo, and Cr). After introducing some basic principles and analytical techniques of these so called "non-traditional" stable isotopes, students will present and discuss recent literature in this arena.

Rules & Requirements

Making Connections Gen Ed: QI.

Grading Status: Letter grade.

GEOL 691H. Honors. 3 Credits.

By permission of the department. For details, see geology degree requirements.

Rules & Requirements

IDEAs in Action Gen Ed: RESEARCH.

Making Connections Gen Ed: EE- Mentored Research.

Grading Status: Letter grade.

GEOL 692H. Honors. 3 Credits.

For details, see geology degree requirements.

Rules & Requirements

IDEAs in Action Gen Ed: RESEARCH.

Making Connections Gen Ed: EE- Mentored Research.

Requisites: Prerequisite, GEOL 691H.

Grading Status: Letter grade.

Graduate-level Courses**GEOL 700. Research Seminar. 1 Credits.**

Required of all entering graduate students or permission of the department. A topical seminar in current research topics in the earth sciences. Presentations by selected faculty with an emphasis on in-depth, critical analysis of current research literature. Two hours a week.

Rules & Requirements

Grading Status: Letter grade.

GEOL 701. Graduate Seminar. 0.5-21 Credits.**Rules & Requirements**

Grading Status: Letter grade.

GEOL 703. Sedimentary Geology I. 3 Credits.

Stratigraphic, sedimentologic, geochemical, petrologic, and paleontologic principles will be summarized. Emphasis is placed on both the techniques used in sedimentary geology and on the characteristics and processes that distinguish sedimentary environments.

Rules & Requirements

Requisites: Prerequisite, GEOL 402.

Grading Status: Letter grade.

GEOL 704. Sedimentary Geology II. 3 Credits.

Continuation of GEOL 703.

Rules & Requirements

Requisites: Prerequisite, GEOL 703.

Grading Status: Letter grade.

GEOL 705. Advanced Petrology I. 3 Credits.

Application of thermodynamics, phase equilibria, thermobarometry, radiogenic and stable isotope geology, and geochemical modeling to the study of igneous and metamorphic rocks and crustal evolution.

Rules & Requirements

Requisites: Prerequisites, CHEM 102, GEOL 304, MATH 233, and PHYS 105.

Grading Status: Letter grade.

GEOL 706. Advanced Petrology II. 3 Credits.

Continuation of GEOL 705.

Rules & Requirements

Requisites: Prerequisite, GEOL 705.

Grading Status: Letter grade.

GEOL 707. Stratigraphic Micropaleontology: Mesozoic Calcareous Nannofossils. 4 Credits.**Rules & Requirements**

Grading Status: Letter grade.

GEOL 708. Stratigraphic Paleontology: Cenozoic Calcareous Nannofossils. 4 Credits.**Rules & Requirements**

Grading Status: Letter grade.

GEOL 709. Proposal Writing and Scientific Communication. 3 Credits.

This course provides a broad view of cutting-edge research across the geo- and marine sciences and develops proposal-writing and scientific communication skills. Proposals follow the NSF Earth Sciences Postdoctoral Fellowships program guidelines and involve peer review and oral presentations. Students will hone their critical thinking and scientific writing skills. They will learn how to craft project objectives and working hypotheses, explain the significance of the problem, outline broader implications, and effectively design a research plan.

Rules & Requirements

Grading Status: Letter grade.

GEOL 710. 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.

Rules & Requirements

Requisites: Prerequisites, GEOL 417, 502, or 503; permission of the instructor for students lacking the prerequisites.

Grading Status: Letter grade.

Same as: MASC 730, ENEC 710.

GEOL 711. Advanced Mineralogy. 3 Credits.**Rules & Requirements**

Grading Status: Letter grade.

GEOL 712. Isotope Geochemistry. 3 Credits.

Survey of isotopic studies in geology; geochronology, crustal evolution, heat flow, paleotemperatures, origin of ore deposits.

Rules & Requirements

Requisites: Prerequisites, CHEM 102, GEOL 301, 303, and 304.

Grading Status: Letter grade.

GEOL 804. Advanced Igneous Petrology. 4 Credits.**Rules & Requirements**

Grading Status: Letter grade.

GEOL 805. Igneous Geochemistry. 4 Credits.**Rules & Requirements**

Grading Status: Letter grade.

GEOL 806. Metamorphic Petrology. 4 Credits.**Rules & Requirements**

Grading Status: Letter grade.

GEOL 809. Tectonophysics. 3 Credits.

Fundamental physical processes necessary for an understanding of plate tectonics; stress and strain in solids; elasticity and flexure; heat transfer; gravity; mantle rheology and convection.

Rules & Requirements

Requisites: Prerequisites, MATH 383, PHYS 201, and 211; Permission of the instructor for students lacking the prerequisites.

Grading Status: Letter grade.

GEOL 851. Seminar in Stratigraphy. 1-15 Credits.**Rules & Requirements**

Grading Status: Letter grade.

GEOL 852. Seminar in Paleoclimatology. 1-15 Credits.**Rules & Requirements**

Grading Status: Letter grade.

GEOL 853. Seminar in Paleontology. 1-15 Credits.**Rules & Requirements**

Grading Status: Letter grade.

GEOL 854. Seminar in Continental Margins. 0.5-21 Credits.**Rules & Requirements**

Grading Status: Letter grade.

GEOL 855. Seminar in Sedimentology. 1-15 Credits.**Rules & Requirements**

Grading Status: Letter grade.

GEOL 856. Seminar in Isotope Geology. 3 Credits.

Introduction to the theory, methods and applications of stable isotopes to low- and high-temperature problems. Primary focus will be on the origin, natural abundance, and fractionation of carbon, hydrogen, and oxygen isotopes.

Rules & Requirements

Grading Status: Letter grade.

GEOL 857. Seminar in Geochemistry. 1-15 Credits.**Rules & Requirements**

Grading Status: Letter grade.

GEOL 858. Seminar in Petrology. 1-15 Credits.**Rules & Requirements**

Grading Status: Letter grade.

GEOL 859. Seminar in Economic Geology. 1-15 Credits.**Rules & Requirements**

Grading Status: Letter grade.

GEOL 860. Seminar in Volcanology. 3 Credits.

All aspects of volcanism will be covered including seismology, geochemistry, deep structure, volcanic products and hazards. Readings of original papers will be stressed.

Rules & Requirements

Grading Status: Letter grade.

GEOL 861. Seminar in Geophysics. 0.5-21 Credits.

Develop explanatory and predictive models of the earth's climate. Introductory level and focused on modeling past climate with the hope of understanding its future. A thorough discussion of current global warming/climate change issues, including the science, history, and controversy, are the main topics of the last third of the course.

Rules & Requirements

Grading Status: Letter grade.

GEOL 862. Seminar in Seismology. 3 Credits.**Rules & Requirements**

Grading Status: Letter grade.

GEOL 863. Seminar in Structural Geology. 1-15 Credits.**Rules & Requirements**

Grading Status: Letter grade.

GEOL 864. Seminar in Tectonics. 3 Credits.

The goal of this seminar is to examine the Cretaceous to Eocene tectonics of the western United States to evaluate the putative flat slab processes responsible. Geologic research on the Laramide Orogeny predates plate tectonic theory, and the explosion of subsequent research warrants a reevaluation of existing theory.

Rules & Requirements

Grading Status: Letter grade.

GEOL 900. Research in Geology. 1-9 Credits.**Rules & Requirements**

Grading Status: Letter grade.

GEOL 993. Master's Research and Thesis. 3 Credits.**Rules & Requirements**

Repeat Rules: May be repeated for credit.

GEOL 994. Doctoral Research and Dissertation. 3 Credits.**Rules & Requirements**

Repeat Rules: May be repeated for credit.

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.

Rules & Requirements

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.

Rules & Requirements

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.

Rules & Requirements

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.

Rules & Requirements

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.

Rules & Requirements

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.

Rules & Requirements

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.

Rules & Requirements

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.

Rules & Requirements

Making Connections Gen Ed: PL.

Requisites: Prerequisite, BIOL 201 or 475.

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.

Rules & Requirements

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.

Rules & Requirements

Making Connections 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.

Rules & Requirements

Making Connections 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.

Rules & Requirements

Grading Status: Letter grade.

Same as: ENEC 444, BIOL 456.

MASC 445. Marine Invertebrate Biology. 4 Credits.

See BIOL 475 for description.

Rules & Requirements

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.

Rules & Requirements

Making Connections 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.

Rules & Requirements

Making Connections 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.

Rules & Requirements

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.

Rules & Requirements

Making Connections Gen Ed: PL.

Requisites: Prerequisites, MATH 231, and PHYS 114 or 118; permission of the instructor for students lacking the prerequisites.

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.

Rules & Requirements

Making Connections Gen Ed: QI.

Requisites: Prerequisites, CHEM 102 and MATH 231; permission of the instructor for students lacking the prerequisites.

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.

Rules & Requirements

Making Connections Gen Ed: QI.

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

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.

Rules & Requirements

Making Connections 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.

Rules & Requirements

Making Connections Gen Ed: EE- Field Work.

Requisites: Prerequisites, CHEM 102 and MATH 231.

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.

Rules & Requirements

Making Connections 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.

Rules & Requirements

Making Connections 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.

Rules & Requirements

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.

Rules & Requirements

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.

Rules & Requirements

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.

Rules & Requirements

Making Connections 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.

Rules & Requirements

Making Connections 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.

Rules & Requirements

Making Connections 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.

Rules & Requirements

Making Connections 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.

Rules & Requirements

Making Connections Gen Ed: PL, CI.

Requisites: Prerequisites, ENVR 421; GEOL 405, 436, 655; MASC 440, 505; or permission of the instructor.

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.

Rules & Requirements

Making Connections 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.

Rules & Requirements

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.

Rules & Requirements

Making Connections Gen Ed: PL, QI.

Requisites: Prerequisite, MATH 233; permission of the instructor for students lacking the prerequisite.

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.

Rules & Requirements

Making Connections Gen Ed: PL, QI.

Requisites: Prerequisite, MASC 506 or 560; permission of the instructor for students lacking the prerequisite.

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.

Rules & Requirements

Making Connections Gen Ed: PL.

Requisites: Prerequisite, MASC 506; permission of the instructor for students lacking the prerequisite.

Grading Status: Letter grade.

Same as: GEOL 563.

MASC 581. Fluvial and Coastal Sediment Dynamics. 3 Credits.

Investigation of engineering equations for sediment transport in unidirectional flow, transport dynamics in coastal systems (waves and currents), and case studies from the literature for rivers through marine environments.

Rules & Requirements

Requisites: Prerequisite, MATH 231; GEOL 101, 103, or 201; permission of the instructor for students lacking the prerequisites.

Grading Status: Letter grade.

Graduate-level Courses**MASC 705. How to Give a Seminar. 1 Credits.**

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.

Rules & Requirements

Grading Status: Letter grade.

MASC 706. Student Interdisciplinary Seminar. 1 Credits.

Marine Sciences graduate students will prepare and present a seminar on an interdisciplinary topic from contemporary research in marine systems.

Rules & Requirements

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.

Rules & Requirements

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.

Rules & Requirements

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.

Rules & Requirements

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.

Rules & Requirements

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.

Rules & Requirements

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.

Rules & Requirements

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 Oceanography. 3 Credits.

Multi-disciplinary survey of circulation, sediment and biological processes operative in estuaries, on the shelf and at the shelf break.

Rules & Requirements

Requisites: Prerequisites, MASC 503 and 506; permission of the instructor for students lacking the prerequisites.

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.

Rules & Requirements

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.

Rules & Requirements

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.

Rules & Requirements

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-Friedrich, characteristics, entropy condition, shock tracking/capturing); spectral, pseudo-spectral methods; particle methods, fast summation, fast multipole/vortex methods.

Rules & Requirements

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.

Rules & Requirements

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).

Rules & Requirements

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.

Rules & Requirements

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.

Rules & Requirements

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.

Rules & Requirements

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.

Rules & Requirements

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.

Rules & Requirements

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.

Rules & Requirements

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.**Rules & Requirements**

Grading Status: Letter grade.

Same as: BIOL 953.

MASC 993. Master's Research and Thesis. 3 Credits.**Rules & Requirements**

Repeat Rules: May be repeated for credit.

MASC 994. Doctoral Research and Dissertation. 3 Credits.**Rules & Requirements**

Repeat Rules: May be repeated for credit.

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