

SCHOOL OF THE EARTH, OCEAN AND ENVIRONMENT

Department Website (https://www.sc.edu/study/colleges_schools/artsandsciences/earth_ocean_and_environment/study/graduate/)

The School of the Earth, Ocean & Environment offers the Ph.D. and the M.S. in Geological Sciences or Marine Science; the Master of Earth and Environmental Resources Management (MEERM) degree; and dual MEERM and Juris Doctor degrees in collaboration with the USC School of Law. The latter is a streamlined program for students seeking both the master's and law degree.

Admission

Admission to the program of graduate study in geological sciences is obtained by application to The Graduate School. Requirements are satisfactory scores on the GRE (normally a minimum total verbal and quantitative GRE score of 1000), with a minimum quantitative score of 550. GRE scores expire after 5 years. However, for admission to the PhD program, students will not be required to retake the GRE if: 1) they have taken the exam and received a minimum total verbal and quantitative score of 1000, with a minimum quantitative score of 550, and 2) they have a Master of Science Degree from an accredited U.S. institution with an undergraduate GPA of 3.00 or higher, and 3) recommendations from qualified referees. Applicants whose native language is not English are also required to submit a satisfactory score on the TOEFL or the IELTS Intl. Academic Course Type 2 exam. The minimum acceptable score on the TOEFL is 80 (internet-based). The minimum acceptable overall band score on the IELTS Intl. Academic Course Type 2 exam is 6.5. The Department of Geological Sciences does not have a specific set of required undergraduate courses but bases its admission mainly on demonstrated ability to do academic work and interest in the field of earth and ocean sciences. Questions concerning admission should be submitted to the director of graduate studies for the School of the Earth, Ocean and Environment (GradDir@seoe.sc.edu).

Programs

- Earth and Environmental Resources Management, M.E.E.R.M. (<https://academicbulletins.sc.edu/graduate/arts-sciences/earth-ocean-environment/earth-environmental-resources-management-meerm/>)
- Geological Sciences, M.S. (<https://academicbulletins.sc.edu/graduate/arts-sciences/earth-ocean-environment/geological-sciences-ms/>)
- Geological Sciences, Ph.D. (<https://academicbulletins.sc.edu/graduate/arts-sciences/earth-ocean-environment/geological-sciences-phd/>)
- Marine Science, M.S. (<https://academicbulletins.sc.edu/graduate/arts-sciences/earth-ocean-environment/marine-science-ms/>)
- Marine Science, Ph.D. (<https://academicbulletins.sc.edu/graduate/arts-sciences/earth-ocean-environment/marine-science-phd/>)

Courses

ENVR 500 - Environmental Practicum (3 Credits)

Multidisciplinary research projects related to University or community environmental problems (e.g., energy, water conservation, solid waste, recycling).

ENVR 501 - Special Topics in the Environment (3 Credits)

An in-depth analysis course of a specific interdisciplinary environmental topic. Course content varies and will be announced in the schedule of classes by title.

Prerequisites: C or better in ENVR 101 or ENVR 201.

ENVR 504 - Climate Geoengineering (3 Credits)

This course will discuss the urgent need for deploying solar radiation and carbon dioxide removal approaches at scale, including potential benefits and risks of these options. It will also discuss regulatory and governance considerations at both the national and international level and strategizes to incentivize large-scale adoption of these approaches.

Cross-listed course: GEOL 504, MSCI 504

ENVR 517 - Socionatural Coastlines in Global Perspective (3 Credits)

A discussion-based seminar course that examines nature-society relations in coastal regions globally. The course will use social theory to understand how uneven development processes shaped – and continue shaping – current coastlines. We will explore key topics including coastal capitalism, delta ecologies, and climate justice via several global case studies.

Cross-listed course: GEOG 517

ENVR 531 - Sustainability Management and Leadership Strategies (3-4 Credits)

Integrated management system principles and advanced leadership strategies to create sustainable development initiatives.

ENVR 533 - Sustainability Projects Course (3 Credits)

Research, development and implementation of sustainability projects throughout the campus and community.

ENVR 534 - Water and Sanitation in Global Perspective (3 Credits)

Interdisciplinary examination of the global policy challenge of ensuring equitable access to water and sanitation services for all.

ENVR 538 - Global Food Politics (3 Credits)

Political, social, and cultural landscapes of food and farming around the world; issues of agricultural production, trade, consumption, and food security.

Cross-listed course: GEOG 538

ENVR 540 - Decolonizing the Environment: Race, Nature, Power (3 Credits)

Critical examination of the ways ideas about nature and racial difference are conceptually and materially entwined with the production of social and environmental inequalities.

ENVR 548 - Environmental Economics (3 Credits)

An analysis of the economics aspects of environmental decay, pollution control, and natural resource use. Analysis of the ability of the market system to allocate resources efficiently when economic activity is accompanied by environmental damage. Discussion of alternative public policy approaches to pollution control and natural resource conservation.

Prerequisites: C or better in ECON 221 and ECON 222 or C or better in ECON 224.

Cross-listed course: ECON 548

ENVR 571 - Conservation Biology (3 Credits)

Principles of conservation biology. Importance of biodiversity, causes of decline and extinction, and restoration and conservation policy in terrestrial and aquatic ecosystems.

Prerequisites: C or better in BIOL 301.

Cross-listed course: BIOL 571

ENVR 572 - Freshwater Ecology (3 Credits)

Quantitative study of the population, community and evolutionary ecology of freshwater habitats (lakes, ponds, rivers, streams, wetlands). Includes mandatory fieldtrips.

Prerequisites: C or better in BIOL 301.

Cross-listed course: BIOL 572

ENVR 700 - Current Topics in Environmental Studies (3 Credits)

Current issues, policies, and regulations pertaining to environmental studies. Emphasizes integrated multidisciplinary approaches toward identification, evaluation, preservation, mitigation, and/or utilization of environmentally sensitive material and sites.

ENVR 709 - Marine Data Science with R (3 Credits)

This course provides a hands-on, project-oriented investigation of current approaches for research in marine science, ecology and environmental science. Components of the course will include exploratory data analyses, statistics, graphics and the R programming language. Prior programming experience is beneficial, but not required.

Cross-listed course: MSCI 709

ENVR 725 - International Environmental Management Systems (3 Credits)

International environmental management systems standards will be integrated with business planning to provide students with the best strategies for future growth in today's environmentally sensitive global economy.

ENVR 790 - Directed Individual Studies (1-6 Credits)

Directed research topics to be individually assigned.

ENVR 795 - Environmental Internship Preparation (1-3 Credits)

Preparation and presentation of a capstone project plan for conduct of multidisciplinary environmental research addressing public/private/non-profit sector issues through an internship in government agencies, NGOs or private industry.

Prerequisites: One semester full-time graduate enrollment or equivalent.

ENVR 796 - Environmental Internship (1-3 Credits)

Environmental internship in government agencies, NGOs, or private industry, culminating in a project deliverable. Typically includes data analyses/metrics, resource management options, and/or internal outreach education, with final assessment. Restricted to graduate students in the MEERM program.

Prerequisites: 3 credits of ENVR 795; successful completion of MEERM comprehensive examination.

ENVR 799 - Thesis Preparation (1-9 Credits)

Thesis Preparation.

ENVR 800 - Seminar in Environmental Studies (3 Credits)

Examination of the effectiveness of environmental policies and methods relative to current issues and needs.

ENVR 802 - Environmental Policy and Management (3 Credits)

An examination of issues related to environmental policy making, implementation and management.

Cross-listed course: POLI 769

ENVR 804 - Environmental Advocacy Seminar (3 Credits)

This seminar is designed to explore and develop practical advocacy skills in the area of environmental representation and to provide an understanding of advocacy in administrative, legislative, and litigation arenas.

Cross-listed course: LAWS 804

ENVR 835 - Seminar in Environmental Ethics (3 Credits)

Examination of the intellectual, cultural, and ethical frameworks within which environmental problems arise and are solved.

Cross-listed course: PHIL 835

GEOL 500 - Field Geology (4-6 Credits)

Geological field techniques including the use of field instruments and the preparation of geologic maps. Written and oral reports required.

Prerequisites: C or better in GEOL 325 and GEOL 355.

Graduation with Leadership Distinction: GLD: Research

GEOL 501 - Principles of Geomorphology (3 Credits)

The process of earth denudation with emphasis on chemistry of weathering, stream and erosion hydraulics, quantitative analysis of land form evolution.

Prerequisites: C or better in GEOL 101.

Cross-listed course: MSCI 501

GEOL 502 - Principles of Coastal Geomorphology (4 Credits)

Geological and physical controls on the morphology, development, and stability of coastlines. Analysis of waves and erosional processes, and coastal zone morphodynamics. Several required field trips.

Prerequisite or Corequisite: D or better in MATH 122 or MATH 141.

Cross-listed course: MSCI 502

GEOL 503 - Regional Stratigraphy and Biostratigraphy of North America (3 Credits)

Sedimentologic, biostratigraphic, and tectonic history of North America, approached from paleogeographic considerations with emphasis on the Atlantic Coastal Plain and Continental Margin. Three hours lecture and three hours recitation per week. Required field trips.

GEOL 504 - Climate Geoengineering (3 Credits)

This course will discuss the urgent need for deploying solar radiation and carbon dioxide removal approaches at scale, including potential benefits and risks of these options. It will also discuss regulatory and governance considerations at both the national and international level and strategizes to incentivize large-scale adoption of these approaches.

Cross-listed course: ENVR 504, MSCI 504

GEOL 511 - Advanced Paleontology (3 Credits)

Systematic, ecologic, biogeographic, and evolutionary aspects of paleontology; lectures, practical exercises, field trips.

Prerequisites: C or better in GEOL 305.

Cross-listed course: MSCI 511

GEOL 515 - Marine Micropaleontology (4 Credits)

Marine microfossils; distribution, ecology, paleoecology, and biostratigraphy; use of microfossils in marine sediments to study oceanographic history. Three lectures and two laboratory hours per week.

Cross-listed course: MSCI 515

GEOL 516 - Sedimentology (4 Credits)

Modern concepts of sediment composition, sedimentary facies, depositional environments, and stratigraphy. Includes laboratory.

Prerequisites: C or better in GEOL 325.

GEOL 518 - Surface to Subsurface Stratigraphy (3 Credits)

Surface to subsurface stratigraphic interpretation and techniques; litho- and biostratigraphy; geophysical log interpretation and subsurface presentation.

GEOL 520 - Isotope Geology and Geochronology (3 Credits)

Dating techniques for Pleistocene deposits, sediments, archaeological materials, igneous and metamorphic rocks.

GEOL 521 - Introduction to Geochemistry (3 Credits)

Investigation of low temperature chemical reactions controlling the geochemistry of the earth's surface. Emphasis on CO₂, carbonates, oxidation-reduction, thermodynamics, isotopes, biogeochemistry.

Cross-listed course: MSCI 521

GEOL 524 - Environmental Radioisotope Geochemistry (3 Credits)

Introduction to radioactivity and the use of radionuclides to study environmental processes, including age-dating and biogeochemical cycling in aquatic systems.

Prerequisites: C or better in CHEM 111, CHEM 112 and MATH 141.

Cross-listed course: MSCI 524

GEOL 526 - Igneous Petrology (4 Credits)

Petrography and petrogenesis of igneous rocks; evolution of contrasting petrotectonic terranes. Three lectures and three laboratory hours per week.

Prerequisites: C or better in GEOL 302.

GEOL 527 - Metamorphic Petrology (4 Credits)

Petrography and petrogenesis of metamorphic rocks in orogenic belts. Three lectures and three laboratory hours per week.

Prerequisites: C or better in GEOL 302.

GEOL 531 - Plate Tectonics (3 Credits)

Geological and geophysical evidence for plate tectonics, detailed development of the plate tectonics model, and present areas of research, including measurements of plate motion using satellite geodesy.

Prerequisites: C or better in two GEOL courses numbered 300 or above, or consent of instructor.

GEOL 537 - Field Methods in Geophysics (3 Credits)

Application of two or more geophysical field methods to a current geological problem. Independent study contract required.

GEOL 540 - Earth Science for Teachers I (3 Credits)

Origin, internal structure and internal processes of the earth, including plate tectonics, earthquakes, volcanoes, and mountain building. Required field trips, two lectures, and three lab hours per week. Cannot be used in MS or PhD programs in geology.

Cross-listed course: EDSE 548

GEOL 541 - Earth Science for Teachers II (3 Credits)

Surface processes acting on the earth; introduction to weather and climate, weathering, erosion, and sedimentary processes; land form evolution; ocean currents and tides, near-shore geologic processes. Required field trips, two lecture, and three lab hours per week. Cannot be used in MS or PhD programs in geology.

Prerequisites: D or better in EDSE 548 or C or better in GEOL 540.

Cross-listed course: EDSE 549

GEOL 542 - Methods in Geoscience Education Research (3 Credits)

Introduction to methods used in discipline-based education research and their application to research questions in the geosciences.

Prerequisites: C or better in least one course in GEOL, ENVR, MSCI or GEOG.

GEOL 545 - Geological Oceanography (3 Credits)

A comprehensive study of the origin and development of the major structural features of the ocean basins and the continental margins. Discussion of the techniques used in obtaining geologic data and the interpretation of sedimentary processes, vulcanism, and the stratigraphy of the ocean basins.

Cross-listed course: MSCI 545

GEOL 546 - Marine Geophysics (3 Credits)

Introduction to the nature and structure of the ocean floor as revealed by geophysical techniques. Two hours lecture and three hours laboratory.

GEOL 548 - Environmental Geophysics (4 Credits)

Practical geophysical techniques for exploring the shallow subsurface. Seismic, resistivity, well log, gravity, magnetic method. Includes lectures and field exercises to collect and analyze data.

Prerequisites: D or better in MATH 141; D or better in PHYS 201 or PHYS 211.

GEOL 550 - Sedimentary Simulations and Sequence Stratigraphy (4 Credits)

Problems of sequence stratigraphy resolved with graphic computer simulations. Sedimentary fill of basins by carbonates and/or clastics tracked as a function of rate of sediment accumulation, tectonic behavior, and sea level. Includes laboratory.

Prerequisites: C or better in GEOL 325.

Cross-listed course: MSCI 550

GEOL 553 - Marine Sediments (3 Credits)

Marine sedimentary environments; physical/biological factors which control the formation and distribution of modern marine sediments.

Prerequisites: C or better in GEOL 516.

Cross-listed course: MSCI 553

GEOL 554 - Applied Seismology (3 Credits)

Theory of seismic wave propagation. Seismic reflection data acquisition, processing, and interpretation.

Prerequisites: D or better in MATH 141; D or better in PHYS 201 or PHYS 211.

GEOL 555 - Elementary Seismology (3 Credits)

Basic elements of seismology. Mathematical development of seismic wave equations; measurement, description, and interpretation of seismic data.

Prerequisites: D or better in MATH 241.

GEOL 556 - Seismic Reflection Interpretation (3 Credits)

The interpretation of geologic structure using seismic sections. Recognition of apparent structure caused by velocity anomalies, multiples, and complex reflector geometry. Application to hydrocarbon exploration.

GEOL 557 - Coastal Processes (3 Credits)

Physical and geological processes controlling the formation and evolution of beach, barrier, and nearshore environments, including discussion of coastal management issues.

Cross-listed course: MSCI 557

GEOL 560 - Earth Resource Management (3 Credits)

An approach to problems of resource management by lecture and seminar using case studies in mineral, energy, hydrogeological, and environmental science.

Graduation with Leadership Distinction: GLD: Research
Experiential Learning: Experiential Learning Opportunity

GEOL 561 - Environmental Field Geology (6 Credits)

An introduction to field methods in sedimentology, structural geology, hydrogeology and geophysics with special reference to geological hazards and environmental problems.

GEOL 567 - Long-Term Environmental Change (3 Credits)

Climatic changes of the past and their impact on the physical landscape, with an emphasis on the Quaternary period.

Prerequisites: C or better in a 200-level course in physical geography or geology or equivalent.

Cross-listed course: GEOG 567

GEOL 568 - Introduction to Micrometeorology (3 Credits)

Small-scale processes in the atmospheric boundary layers, including energy budget, radiation, soil heat transfer, humidity, viscous flows, turbulence, momentum and heat exchanges, evaporation, and marine atmospheric boundary layer.

Prerequisites: C or better in PHYS 201 and MATH 141.

Cross-listed course: MSCI 568

GEOL 570 - Environmental Hydrogeology (3 Credits)

Environmental considerations of the hydrologic cycle, occurrence and movement of ground water, aquifer analysis, and water well emplacement and construction. Water quality, pollution parameters, and the geochemistry of selected natural systems. The effects of environmental problems, waste disposal, and urban development upon the aqueous geochemical regime.

Prerequisites: C or better in GEOL 101 and D or better in CHEM 111 or their equivalents.

GEOL 571 - Soil Hydrology (4 Credits)

Saturated and unsaturated water flow through soils, pore pressure development, runoff generation, and watershed response to rainfall. Three lecture and three laboratory hours per week.

Prerequisites: D or better in PHYS 202 and MATH 142.

GEOL 575 - Numerical Modeling for Earth Science Applications (3 Credits)

Finite difference and finite element methods for solving the diffusion equation and advection-dispersion equation, with applications in hydrogeology, geophysics, geology, and marine science.

Prerequisites: D or better in MATH 142; MATH 241 is recommended.

GEOL 579 - Air-Sea Interaction (3 Credits)

The physical mechanism responsible for interaction between the ocean and the atmosphere and the influence of air-sea interaction on atmospheric and oceanic dynamics and thermodynamics on a wide variety of spatial/temporal scales.

Cross-listed course: MSCI 579

GEOL 580 - Satellite Oceanography (3 Credits)

This course provides knowledge of various techniques used in satellite remote sensing of the oceans. Key skills will be developed in satellite data processing, image analysis, and hands-on research.

Cross-listed course: MSCI 580

GEOL 581 - Estuarine Oceanography (3 Credits)

Estuarine kinematics and dynamics; classification of estuaries; estuarine circulation and mixing. Scheduled field trips are required.

Prerequisites: C or better in MSCI 314.

Cross-listed course: MSCI 581

GEOL 582 - Marine Hydrodynamics (3 Credits)

Basic principles of fluid statics and dynamics. Conservation of mass, momentum, and energy; viscosity, vorticity, and boundary layers with examples from the marine environment. Applications to and analysis of ocean currents and waves.

Prerequisites: C or better in MATH 241 and C or better in either PHYS 201 or PHYS 211.

Cross-listed course: MSCI 582

GEOL 583 - Geology and Geochemistry of Salt Marshes (3 Credits)

Geological and geochemical processes in salt marshes. Methods of geological research in marshes including instrumental techniques, sampling design, and data analysis. Two lectures per week plus four weekends of project oriented fieldwork and/or equivalent lab work. Scheduled field trips are required.

Cross-listed course: MSCI 583

GEOL 599 - Topics in Geological Science (1-3 Credits)

Current developments in geological science selected to meet faculty and student interests. Course content varies and will be announced by title in schedule of courses.

Prerequisites: C or better in GEOL 101, GEOL 103 or GEOL 201 or graduate student standing in the School of the Earth, Ocean and Environment (SEOE).

GEOL 600 - Senior Seminar in Geology and Geophysics (2 Credits)

Advanced research topics in geology and geophysics; critical reading of literature, technical presentations, and written reports. Senior standing.

GEOL 650 - Electron Microscopy and Microanalysis (4 Credits)

SEM, ESEM, TEM, and EMPA, WDS quantitative analysis, EDS semi-quantitative analysis, EBSD, methods of sample preparation, and applications in varieties of disciplines. Two lecture and three laboratory hours per week.

Prerequisites: D or better in CHEM 111 or equivalent.

GEOL 699 - Senior Thesis (3-6 Credits)

Senior capstone experience, research on a problem on fundamental significance, supervised by faculty member; must include field study component, written final project report, and oral presentation at departmental seminar.

GEOL 700 - Geology of South Carolina (3 Credits)

Survey of the surficial, coastal, and bedrock geology of South Carolina, its regional physiographic and tectonic setting, and the natural resources of the state.

GEOL 702 - Environmental Earth Science for Teachers (3 Credits)

The hydrologic cycle in geologic settings of this region, and the effects of urbanization and industrialization on groundwater, rivers, and coasts. The vulnerability of urban and industrial systems to natural geologic processes. Two lecture and three laboratory hours per week. Not available for graduate credit for students in M.S. or Ph.D. programs in geological sciences.

Prerequisites: introductory course in any of the earth sciences.

GEOL 703 - Field Studies in Pleistocene and Holocene Geology for Teachers (1 Credit)

Two weekend field courses dealing with Pleistocene and Holocene coastal geology, plate tectonics, sea-level change, global circulation patterns, shoreline change since 1850, and nearshore processes.

GEOL 704 - Field Studies for Teachers in Natural and Altered Barrier Island Systems (1 Credit)

Two weekend field courses dealing with barrier island and associated marsh environments, marsh productivity, the dune-beach-bar system, shoreline stabilization, and nearshore processes on natural and armored shorelines.

GEOL 711 - Paleoclimatology (3 Credits)

An overview of Earth's climate history during Cenozoic. Emphasis will be placed on Pleistocene glacial-interglacial climate variability and understanding the proxies used to reconstruct past climate changes.

Cross-listed course: MSCI 711

GEOL 715 - Stable Isotope Geochemistry (3 Credits)

Introduction to the analysis of stable isotopes of hydrogen, oxygen, carbon, nitrogen, and sulfur using mass spectrometry. Emphasis will be on the use of these isotopes in geological problems.

Prerequisites: GEOL 521.

GEOL 716 - Eustasy and Global Variations in Sequence Stratigraphy (3 Credits)

Relationship of sequence stratigraphy to sea level variations, tectonics and sedimentation. Construction and analyses of paleogeographic maps, regional cross-sections, and chronostratigraphic charts.

Cross-listed course: MSCI 716

GEOL 717 - Organic Geochemistry (3 Credits)

Sources, transport, and fate of organic matter in natural environments including soils, riverine, estuarine, coastal and open ocean sediments and waters.

Prerequisites: GEO 521L/MSCI 521.

Cross-listed course: MSCI 717

GEOL 720 - Crystal Chemistry and Mineral Structure (3 Credits)

Principles of atomic structure and chemical variation of minerals.

GEOL 722 - Aqueous Geochemistry (3 Credits)

This course was not found in the supplied content but was listed in the program requirements. If possible, please provide us with the correct information.

GEOL 725 - Solid Earth Processes (3 Credits)

Examination of the structure and dynamics of the Earth's interior combining perspectives from geophysics and geochemistry. Focus on the lithospheric cycle.

GEOL 726 - Igneous Processes and Crustal Genesis (3 Credits)

An investigation of igneous processes and their role in crustal genesis and evolution.

GEOL 731 - Advanced Structural Geology (3 Credits)

A study of the deformation of the earth's crust including mechanics of folding, faulting, jointing, and cleavage formation. Consideration of current theories of orogenesis in relation to geophysical evidence for the structure of the earth's crust, mantle, and core.

Prerequisites: GEOL 331 and GEOL 536.

GEOL 733 - Rock Mechanics (3 Credits)

Behavior of rocks and minerals up to 10kb, 8000°C. Role of internal pore pressure and time. Interplay of theory and empiricism.

Prerequisites: MATH 300.

GEOL 735 - Regional Tectonics (3 Credits)

Integrated analysis (from both model and case history approaches) of the regional structural geology of selected classic areas and analysis of the interaction of tectonic and sedimentary processes in the production of the sedimentary sequences of selected geosynclines and basins. Weekend field trips.

GEOL 743 - Decision Making in Environmental Resource Management (3 Credits)

Environmental project planning and management. Types and magnitudes of environmental problems; environmental pathways; environmental data acquisition and analysis; protection versus restoration; risk assessment; site assessment.

Prerequisites: GEOL 560.

GEOL 744 - Decision Making in Energy Resource Management (3 Credits)

An integrative seminar for science managers. Consideration of the technical, managerial, and financial aspects of decision making in geologic enterprises, with emphasis on hydrocarbon exploration.

GEOL 745 - Petroleum Geology (3 Credits)

An introduction to exploring for oil and natural gas; concentration on specific regions with energy resources.

GEOL 750 - Basin Analysis Seminar (3 Credits)

Development of the stratigraphic systems; detailed analysis of the aims, working methods, and relations between litho-, bio-, and chronostratigraphy. Three lecture hours per week with occasional field trips.

GEOL 751 - Carbonate Petrology (3 Credits)

Detailed analysis of the processes and products of carbonate sedimentation, diagenesis, and lithification, with special emphasis upon the role of organisms in forming carbonate sediments and sedimentary rocks. Three lecture hours per week with occasional field trips.

GEOL 752 - Sandstone Petrology (3 Credits)

Sandstone properties as a response to geologic processes. Relationships between the porous microstructure of sandstones and fluid transport. Automated petrography using image analysis and pattern recognition procedures.

GEOL 754 - Oceanographic Techniques (1 Credit)

Shipboard experience with basic techniques used by geological, physical, chemical, and biological oceanographers.

Cross-listed course: BIOL 754

GEOL 755 - Environmental Measurements and Analysis (3 Credits)

A field and laboratory course designed to acquaint students with basic techniques needed to measure and analyze various biotic and abiotic environmental parameters in estuarine and shallow water habitats. One lecture and six laboratory hours per week.

GEOL 758 - Analysis of Geological Data (3 Credits)

Principles used in processing, smoothing, correlating and contouring geological data and simulating geologic processes.

GEOL 764 - Seismic Reflection Interpretation (3 Credits)

The interpretation of regional stratigraphy and structure using seismic sections. Recognition of stratigraphic sequences, sedimentary facies, and extensional and compressional structures. Application to hydrocarbon exploration.

GEOL 765 - Exploration Seismology (3 Credits)

Seismic refraction and reflection methods including sources, instrumentation, data processing, velocity analysis, seismic modeling, and interpretation.

Prerequisites: GEOL 536 or equivalent.

GEOL 766 - Advanced Seismology (3 Credits)

Advanced treatment of elastic wave propagation, ray theory, normal modes, and free oscillations; applications to determine earth structure, modeling of earthquakes.

Prerequisites: GEOL 555 or equivalent.

GEOL 770 - Ground Water Geology (3 Credits)

The evaluation of aquifer characteristics by flow nets, Theis equation and graphic solution technique for water table and artesian conditions. Methodology of pumping tests and data collection. Prediction of aquifer response through time. Analog and computer analysis and interpretation of data.

Prerequisites: GEOL 570 or equivalent.

GEOL 771 - Topics in Hydrogeology (3 Credits)

Selected topics germane to the qualitative and quantitative aspects of the hydrologic cycle.

GEOL 772 - Geologic Theories (3 Credits)

Survey of the origin and development of geologic principles.

GEOL 773 - Water Quality and Pollution (3 Credits)

The nature of water; physical, chemical, and biological quality parameters. Techniques of quantitative analysis, methods of water quality control, and pollution abatement. Hydrogeochemical interactions and effects on water quality and waste disposal.

Prerequisites: GEOL 570 or equivalent.

GEOL 774 - Solute Transport in Geologic Media (3 Credits)

Processes influencing conservative and reactive transport of solutes through porous media. Geochemistry of natural waters; transport processes for geologic and environmental/contaminant problems; mathematical equations; numerical methods; field techniques.

Prerequisites: GEOL 570 or ECIV 563.

GEOL 775 - Numerical Methods in Subsurface Hydrology (3 Credits)

Formation of groundwater flow and solute transport problems, theory and practice, numerical methods, solution techniques.

Cross-listed course: ECIV 761

GEOL 781 - Physical Oceanography (3 Credits)

Geographic and hydrodynamic aspects of oceanography, with emphasis on estuaries. Physical properties of sea water and theories and methods involved in ocean currents, air-sea interaction, waves, and tides.

Cross-listed course: MSCI 781

GEOL 782 - Chemical Oceanography (3 Credits)

Chemical characteristics of sea water, distribution of properties, and chemical processes in the oceans, with emphasis on estuaries.

Cross-listed course: MSCI 782

GEOL 783 - Oceanographic Time Series Analysis (3 Credits)

Techniques in the analysis of oceanographic data sequences, including filtering techniques, fast Fourier transformers, and empirical orthogonal functions.

Cross-listed course: MSCI 783

GEOL 784 - Geophysical Fluid Dynamics (3 Credits)

Equations governing the large-scale dynamics of the atmosphere and ocean, rotational influence, shallow water equations, vorticity, quasi-geostrophic dynamics, Rossby waves, energy and enstrophy, and geostrophic turbulence.

Prerequisites: MATH 241 or ECIV 360 or GEOL 582/MSCI 582 or GEOL 781/MSCI 781.

Cross-listed course: MSCI 784

GEOL 785 - Atmospheric Dynamics (3 Credits)

Elementary applications of the basic equations, scale analysis, planetary boundary layer, atmospheric oscillations, synoptic and mesoscale systems, hydrodynamic instability, cyclogenesis, frontogenesis, energy cycle, momentum budget, and tropical motion systems.

Cross-listed course: MSCI 785

GEOL 790 - Directed Individual Studies in Geology (1-6 Credits)

Directed research topics to be individually assigned and supervised by graduate faculty.

GEOL 799 - Thesis Preparation (1-9 Credits)**GEOL 800 - Seminar (General Geology) (0-1 Credits)**

Required of all graduate students.

GEOL 801 - Seminar in Paleontology (2 Credits)**GEOL 802 - Seminar in Paleobotany (2 Credits)**

Readings and discussions on current topics.

GEOL 803 - Seminar in Stratigraphy (2 Credits)

Critical analysis of recent papers dealing with the reconstruction of marine paleoenvironments based on deep sea sediments. Emphasis will be placed on specific intervals of geologic time. Two discussion hours per week.

GEOL 804 - Seminar in Stratigraphy (2 Credits)**GEOL 805 - Seminar in Earth and Ocean Science Education (1 Credit)**

Interactive community outreach and middle school geoscience education for graduate students interested in outreach at the K-12 level.

GEOL 818 - Seminar in Geophysics (2 Credits)

Seminar related to current topics in geophysics.

GEOL 819 - Seminar in Tectonophysics (2 Credits)

Readings and discussion on current tectonophysical problems.

GEOL 821 - Seminar in Mineralogy (2 Credits)**GEOL 824 - Seminar in Geochemistry (2 Credits)****GEOL 831 - Seminar in Structural Geology (2 Credits)****GEOL 832 - Seminar in Structural Geology (2 Credits)****GEOL 833 - Seminar in Structural Geology (2 Credits)****GEOL 834 - Seminar in Structural Geology (2 Credits)****GEOL 841 - Seminars in Petrology (2 Credits)****GEOL 842 - Seminar in Petrology (2 Credits)****GEOL 843 - Seminar in Petrology (2 Credits)****GEOL 844 - Seminar in Sedimentology (2 Credits)****GEOL 851 - Seminar in Sedimentology (2 Credits)****GEOL 854 - Seminar in Geomorphology (2 Credits)****GEOL 861 - Seminar in Hydrogeology (3 Credits)****GEOL 862 - Seminar in Hydrogeology (3 Credits)**

GEOL 888 - Data Presentation Workshop (3 Credits)

Preparation and presentation, oral and written, of geological data, discussed via examples from students' own work and from published material.

GEOL 899 - Dissertation Preparation (1-12 Credits)**MSCI 501 - Principles of Geomorphology (3 Credits)**

The process of earth denudation with emphasis on chemistry of weathering, stream and erosion hydraulics, quantitative analysis of land form evolution.

Prerequisites: C or better in GEOL 101.

Cross-listed course: GEOL 501

MSCI 502 - Principles of Coastal Geomorphology (4 Credits)

Geological and physical controls on the morphology, development, and stability of coastlines. Analysis of waves and erosional processes, and coastal zone morphodynamics. Several required field trips.

Prerequisite or Corequisite: D or better in MATH 122 or MATH 141.

Cross-listed course: GEOL 502

MSCI 503 - Environmental Microbiology (3 Credits)

An overview of the microbial world including a survey of the distribution, functioning, and diversity of microorganisms in natural systems. Discusses the crucial roles that microorganisms play in ecosystem function, biogeochemical cycles, and environmental quality.

Prerequisites: MSCI 102 or BIOL 102, CHEM 112.

Cross-listed course: BIOL 502

MSCI 504 - Climate Geoengineering (3 Credits)

This course will discuss the urgent need for deploying solar radiation and carbon dioxide removal approaches at scale, including potential benefits and risks of these options. It will also discuss regulatory and governance considerations at both the national and international level and strategizes to incentivize large-scale adoption of these approaches.

Cross-listed course: ENVR 504, GEOL 504

MSCI 505 - Senior Seminar (1 Credit)**MSCI 509 - MATLAB-Based Data Analysis in Ocean Sciences (3 Credits)**

MATLAB-based course in processing, analysis, and visualization of large oceanographic data sets. Includes scalar and vector time series measured at fixed locations as well as shipboard surveys of oceanographic characteristics varying both in 3-D and in time. Methods and techniques are relevant to other geoscience disciplines.

Prerequisites: MATH 141.

MSCI 510 - Invertebrate Zoology (4 Credits)

Phylogenetic and comparative aspects of anatomy, physiology, reproduction, and embryology of the invertebrates. Three lecture and one three-hour laboratory period per week.

Prerequisites: C or better in BIOL 301 or MSCI 311.

Cross-listed course: BIOL 510

Graduation with Leadership Distinction: GLD: Research

MSCI 511 - Advanced Paleontology (3 Credits)

Systematic, ecologic, biogeographic, and evolutionary aspects of paleontology; lectures, practical exercises, field trips.

Prerequisites: C or better in GEOL 305.

Cross-listed course: GEOL 511

MSCI 515 - Marine Micropaleontology (4 Credits)

Marine microfossils; distribution, ecology, paleoecology, and biostratigraphy; use of microfossils in marine sediments to study oceanographic history. Three lectures and two laboratory hours per week.

Cross-listed course: GEOL 515

MSCI 521 - Introduction to Geochemistry (3 Credits)

Investigation of low temperature chemical reactions controlling the geochemistry of the earth's surface. Emphasis on CO₂, carbonates, oxidation-reduction, thermodynamics, isotopes, biogeochemistry.

Cross-listed course: GEOL 521

MSCI 524 - Environmental Radioisotope Geochemistry (3 Credits)

Introduction to radioactivity and the use of radionuclides to study environmental processes, including age-dating and biogeochemical cycling in aquatic systems.

Prerequisites: C or better in CHEM 111, CHEM 112 and MATH 141.

Cross-listed course: GEOL 524

MSCI 525 - Marine Plants (4 Credits)

Diversity, distribution, physiology, ecology, evolution, and economic importance of marine algal, seagrass, and mangrove communities. Three lecture and three laboratory hours per week. Scheduled field trips are required.

Prerequisites: BIOL 301 or MSCI 311.

Cross-listed course: BIOL 525

MSCI 535 - Fishery Management (3 Credits)

Management and conservation of aquatic and marine resources, with emphasis on fisheries. Data procurement and analysis; commercial and recreational fisheries; sociological, political, legal, and environmental factors that affect fishery management; and fish biodiversity.

Prerequisites: BIOL 301.

Cross-listed course: BIOL 535

MSCI 536 - Ichthyology (4 Credits)

Phylogeny, morphology, behavior, and ecology of fishes. Three lecture and 3 laboratory hours plus three field trips to be arranged.

Prerequisites: BIOL 301 or MSCI 311.

Cross-listed course: BIOL 536

Graduation with Leadership Distinction: GLD: Research

MSCI 537 - Aquaculture (3 Credits)

Introduction to the practical and scientific aspects of the commercial culture of freshwater and marine organisms. Three lecture hours per week. One all-day field trip required.

Prerequisites: BIOL 301 or MSCI 311.

Cross-listed course: BIOL 537

MSCI 538 - Behavior of Marine Organisms (4 Credits)

The identification of behavioral adaptations of estuarine and marine organisms: their ecology, physiology, development, and evolutionary history; field observations.

Prerequisites: BIOL 101 and BIOL 102 or MSCI 311.

Cross-listed course: BIOL 538

Graduation with Leadership Distinction: GLD: Research

MSCI 545 - Geological Oceanography (3 Credits)

A comprehensive study of the origin and development of the major structural features of the ocean basins and the continental margins. Discussion of the techniques used in obtaining geologic data and the interpretation of sedimentary processes, vulcanism, and the stratigraphy of the ocean basins.

Cross-listed course: GEOL 545

MSCI 550 - Sedimentary Simulations and Sequence Stratigraphy (4 Credits)

Problems of sequence stratigraphy resolved with graphic computer simulations. Sedimentary fill of basins by carbonates and/or clastics tracked as a function of rate of sediment accumulation, tectonic behavior, and sea level. Includes laboratory.

Prerequisites: C or better in GEOL 325.

Cross-listed course: GEOL 550

MSCI 552 - Population Genetics (3 Credits)

An introduction to the principles of population genetics, with emphasis on the origin, maintenance, and significance of genetic variation in natural populations.

Prerequisites: C or better in BIOL 301 or MSCI 311.

Cross-listed course: BIOL 552

Graduation with Leadership Distinction: GLD: Research

MSCI 553 - Marine Sediments (3 Credits)

Marine sedimentary environments; physical/biological factors which control the formation and distribution of modern marine sediments.

Prerequisites: C or better in GEOL 516.

Cross-listed course: GEOL 553

MSCI 555 - Conservation and Health in Marine Systems (3 Credits)

Introduces the field of conservation and explores the intersection between conservation and environmental health with a particular focus on coastal and marine case studies.

MSCI 557 - Coastal Processes (3 Credits)

Physical and geological processes controlling the formation and evolution of beach, barrier, and nearshore environments, including discussion of coastal management issues.

Cross-listed course: GEOL 557

MSCI 566 - Ecosystem Analysis (3 Credits)

The formulation and simulation of compartment models of marine and terrestrial ecosystems with complex nutrient cycling, food chains, and energy flow. Analog and digital simulation techniques. Ecosystem stability and sensitivity. Organization, structure, and diversity of an ecosystem.

MSCI 568 - Introduction to Micrometeorology (3 Credits)

Small-scale processes in the atmospheric boundary layers, including energy budget, radiation, soil heat transfer, humidity, viscous flows, turbulence, momentum and heat exchanges, evaporation, and marine atmospheric boundary layer.

Prerequisites: C or better in PHYS 201 and MATH 141.

Cross-listed course: GEOL 568

MSCI 574 - Marine Conservation Biology (3 Credits)

Exploration of how human activities affect marine natural populations, species, communities and ecosystems, including threats to biodiversity; approaches to marine conservation; and ecological and evolutionary responses to anthropogenic disturbance.

Prerequisites: BIOL 301.

Cross-listed course: BIOL 574

MSCI 575 - Marine Ecology (3 Credits)

Structure, dynamics, and interactions between populations and communities in marine ecosystems. Attendance at designated departmental seminars is required. Three lecture hours per week.

Prerequisites: CHEM 111 and BIOL 301 or MSCI 311.

Cross-listed course: BIOL 575

MSCI 575L - Marine Ecology Laboratory (1 Credit)

Laboratory and field exercises in coastal environments. Three hours per week plus field trips.

Prerequisite or Corequisite: MSCI 575 or BIOL 575.

Cross-listed course: BIOL 575L

MSCI 576 - Marine Fisheries Ecology (3 Credits)

Interdisciplinary examination of the distribution, reproduction, survival, and historical variation of the principal commercial marine fisheries.

Prerequisites: BIOL 301.

Cross-listed course: BIOL 576

MSCI 577 - Ecology of Coral Reefs (4 Credits)

Structure, productivity, and biodiversity of coral reefs, emphasizing their sensitivity, stability, and sustainability. Taught as an extended field experience with daily lectures and guided research activities.

Prerequisites: BIOL 301 or MSCI 311.

Cross-listed course: BIOL 577

MSCI 578 - Physiological and Pollution Ecology of Marine Organisms (3 Credits)

Functional adaptation of marine plants and animals to ecological stresses including pollution. Three lecture hours per week.

Prerequisites: MSCI 311 or equivalent.

MSCI 579 - Air-Sea Interaction (3 Credits)

The physical mechanism responsible for interaction between the ocean and the atmosphere and the influence of air-sea interaction on atmospheric and oceanic dynamics and thermodynamics on a wide variety of spatial/temporal scales.

Cross-listed course: GEOL 579

MSCI 580 - Satellite Oceanography (3 Credits)

This course provides knowledge of various techniques used in satellite remote sensing of the oceans. Key skills will be developed in satellite data processing, image analysis, and hands-on research.

Cross-listed course: GEOL 580

MSCI 581 - Estuarine Oceanography (3 Credits)

Estuarine kinematics and dynamics; classification of estuaries; estuarine circulation and mixing. Scheduled field trips are required.

Prerequisites: C or better in MSCI 314.

Cross-listed course: GEOL 581

MSCI 582 - Marine Hydrodynamics (3 Credits)

Basic principles of fluid statics and dynamics. Conservation of mass, momentum, and energy; viscosity, vorticity, and boundary layers with examples from the marine environment. Applications to and analysis of ocean currents and waves.

Prerequisites: C or better in MATH 241 and C or better in either PHYS 201 or PHYS 211.

Cross-listed course: GEOL 582

MSCI 583 - Geology and Geochemistry of Salt Marshes (3 Credits)

Geological and geochemical processes in salt marshes. Methods of geological research in marshes including instrumental techniques, sampling design, and data analysis. Two lectures per week plus four weekends of project oriented fieldwork and/or equivalent lab work. Scheduled field trips are required.

Cross-listed course: GEOL 583

MSCI 585 - Coastal Tropical Oceanography (4 Credits)

Descriptive oceanography of mangrove and coral reef coasts with emphasis on physical processes. Taught as an extended field experience with daily lectures and guided research activities.

Prerequisites: MSCI 312.

MSCI 590 - Beach-Dune Interactions (3 Credits)

Influence of wind on coastal systems, with emphasis on nearshore currents, sediment transport and bedforms, aeolian transport, and dunes. Minimum Junior standing required.

Cross-listed course: GEOG 590

MSCI 599 - Topics in Marine Science (1-3 Credits)

Current developments in marine science selected to meet faculty and student interests. Course content varies and will be announced by title in schedule of courses.

MSCI 624 - Aquatic Chemistry (3 Credits)

Study of the chemical reactions and processes affecting the distribution of chemical species in natural systems. Three lecture hours per week.

Prerequisite or Corequisite: CHEM 321, MATH 142.

Cross-listed course: CHEM 624

MSCI 627 - Marine Phytoplankton (3 Credits)

Examines the physiology and ecology of phytoplankton, including environmental controls on community composition, primary productivity, and detection and characterization of water quality (eutrophication) and harmful algal blooms.

Prerequisites: MSCI 102 or MSCI 450 or BIOL 450.

Cross-listed course: BIOL 627

MSCI 709 - Marine Data Science with R (3 Credits)

This course provides a hands-on, project-oriented investigation of current approaches for research in marine science, ecology and environmental science. Components of the course will include exploratory data analyses, statistics, graphics and the R programming language. Prior programming experience is beneficial, but not required.

Cross-listed course: ENVR 709

MSCI 711 - Paleoclimatology (3 Credits)

An overview of Earth's climate history during Cenozoic. Emphasis will be placed on Pleistocene glacial-interglacial climate variability and understanding the proxies used to reconstruct past climate changes.

Cross-listed course: GEOL 711

MSCI 716 - Eustasy and Global Variations in Sequence Stratigraphy (3 Credits)

Relationship of sequence stratigraphy to sea level variations, tectonics and sedimentation. Construction and analyses of paleogeographic maps, regional cross-sections, and chronostratigraphic charts.

Cross-listed course: GEOL 716

MSCI 717 - Organic Geochemistry (3 Credits)

Sources, transport, and fate of organic matter in natural environments including soils, riverine, estuarine, coastal and open ocean sediments and waters.

Prerequisites: GEO 521L/MSCI 521.

Cross-listed course: GEOL 717

MSCI 745 - Geological Oceanography (3 Credits)

A comprehensive study of the origin and development of the major structural features of the ocean basins and the continental margins. Discussion of the techniques used in obtaining geologic data and the interpretation of sedimentary processes, vulcanism, and the stratigraphy of the ocean basins.

MSCI 750 - Advanced Biological Oceanography (3 Credits)

Three lecture hours per week.

Prerequisites: BIOL 450/MSCI 450.

Cross-listed course: BIOL 750

MSCI 752 - Marine Biogeochemistry (3 Credits)

Biological, geological, and physical processes that influence the cycling of major bioactive elements (C, O, N, P, S) in marine waters and sediments.

Cross-listed course: BIOL 752

MSCI 754 - Oceanographic Techniques (1 Credit)

MSCI 755 - Marine Conservation and Environmental Health (3 Credits)
Explores the intersection between conservation and environmental health with a particular focus on coastal and marine case studies.

Cross-listed course: ENHS 755

MSCI 758 - Special Topics in Marine Sciences (1-3 Credits)**MSCI 767 - Ecological Modeling and Environmental Planning (4 Credits)**

Concepts in systems ecology and ecological modeling. Emphasis on the use of models and computer simulations in examining environmental interactions, predicting environmental impact, and facilitating the process of environmental planning. Lab practice in model development and computer simulation analysis.

Prerequisites: MATH 111 or equivalent, ecology, ENHS 660.

Cross-listed course: BIOL 768, ENHS 767

MSCI 769 - Reproductive Ecology (3 Credits)

Theoretical aspects and examples of the variety of reproductive and life history patterns found in animals and plants as adaptations to various environmental constraints. Three lecture hours per week.

Prerequisites: BIOL 570.

Cross-listed course: BIOL 769

MSCI 777 - Current Topics in Marine Ecology for Teachers (3 Credits)

Primarily for teachers. Marine science materials with emphasis on coastal environments. Field exercises.

MSCI 778 - Current Topics in Marine Ecology for Teachers (3 Credits)

Primarily for teachers. Marine science materials with emphasis on coastal environments. Field exercises.

MSCI 781 - Physical Oceanography (3 Credits)

Geographic and hydrodynamic aspects of oceanography, with emphasis on estuaries. Physical properties of sea water and theories and methods involved in ocean currents, air-sea interaction, waves, and tides.

Cross-listed course: GEOL 781

MSCI 782 - Chemical Oceanography (3 Credits)

Chemical characteristics of sea water, distribution of properties, and chemical processes in the oceans, with emphasis on estuaries.

Cross-listed course: GEOL 782

MSCI 783 - Oceanographic Time Series Analysis (3 Credits)

Techniques in the analysis of oceanographic data sequences, including filtering techniques, fast Fourier transformers, and empirical orthogonal functions.

Cross-listed course: GEOL 783

MSCI 784 - Geophysical Fluid Dynamics (3 Credits)

Equations governing the large-scale dynamics of the atmosphere and ocean, rotational influence, shallow water equations, vorticity, quasi-geostrophic dynamics, Rossby waves, energy and enstrophy, and geostrophic turbulence.

Prerequisites: MATH 241 or ECIV 360 or GEOL 582/MSCI 582 or GEOL 781/MSCI 781.

Cross-listed course: GEOL 784

MSCI 785 - Atmospheric Dynamics (3 Credits)

Elementary applications of the basic equations, scale analysis, planetary boundary layer, atmospheric oscillations, synoptic and mesoscale systems, hydrodynamic instability, cyclogenesis, frontogenesis, energy cycle, momentum budget, and tropical motion systems.

Cross-listed course: GEOL 785

MSCI 790 - Directed Individual Studies in Marine Sciences (1-6 Credits)

Directed research topics to be individually assigned and supervised by graduate faculty.

MSCI 795 - Issues in Coastal Environmental Health (3 Credits)

Problems associated with coastal population growth and development. Emphasis is on the working group approach to ameliorating impacts on ecosystem and human health.

Cross-listed course: ENHS 795

MSCI 798 - Research in Marine Science (1-9 Credits)

In depth research methods and techniques in preparation of thesis or dissertation.

MSCI 799 - Thesis Preparation (1-9 Credits)

MSCI 800 - Marine Science Seminar (0 Credits)

Advanced topics in Marine Science research presented in Seminar format. Class meets weekly, every semester, during the Marine Science Program seminar.

MSCI 899 - Dissertation Preparation (1-12 Credits)