Marine, Earth, and Atmospheric Sciences (MEA)

MEA 100 Earth System Science: Exploring the Connections (4 credit hours)
An introduction to the processes of and linkages among major components of planet Earth. Geosphere, hydrosphere, atmosphere, biosphere as dynamic and interdependent systems. Influence of human activity on earth systems. Optional weekend field trip.

Prerequisite: Competence in high school algebra and chemistry
GEP Global Knowledge, GEP Natural Sciences, GEP Interdisciplinary Perspectives
Typically offered in Fall, Spring, and Summer

MEA 101 Geology I: Physical (3 credit hours)
Systematic consideration of processes operating on and below the earth's surface and the resulting features of landscape, earth structures, and earth materials. Occurrences and utilization of the earth's physical resources.

Corequisite: Recommended that MEA 110 be taken concurrently
GEP Natural Sciences
Typically offered in Fall, Spring, and Summer

MEA 110 Geology I Laboratory (1 credit hours)
Scientific methodology applied to the study of common rock-forming minerals, common rocks, topographic maps, geologic structures and geological maps. Field trips.

Corequisite: MEA 101 or Prerequisite: MEA 100, MEA 101, MEA 120, MEA 140 or MEA 200
GEP Natural Sciences
Typically offered in Fall, Spring, and Summer

MEA 130 Introduction to Weather and Climate (3 credit hours)
Explores the structure, physical causes, and climatology of weather systems including the jet streams, mid-latitude cyclones, hurricanes, thunderstorms, and tornadoes. Clouds and precipitation, air pollution, climate modification, optical effects (rainbows, halos) and weather instruments. Weather systems and forecasting techniques are illustrated through daily weather map discussions.

Prerequisite: For Non-Majors
GEP Natural Sciences
Typically offered in Fall, Spring, and Summer

MEA 135 Introduction to Weather and Climate Laboratory (1 credit hours)
Experiments include effects of air pressure change on temperature and density (gas law); measurement of atmospheric moisture; formation of clouds and hail; effects of variable solar heating. Graphical display and interpretation of data; weather instruments and observations; weather map analysis; forecasting principles.

Corequisite: MEA 130
GEP Natural Sciences
Typically offered in Fall and Spring

MEA 150 Environmental Issues in Water Resources (4 credit hours)
The science of current environmental concerns, particularly those related to water resources. Major topics include weather and climate, natural resource cycles, resource depletion and contamination, societal impacts. Scientific aspects of environmental issues. Required field trips.

GEP Natural Sciences
Typically offered in Fall only

MEA 200 Introduction to Oceanography (3 credit hours)
The ocean as a part of our environment including interactions between atmosphere and ocean, ocean circulation, physical and chemical properties of sea water, marine geology and marine biology.

Corequisite: Recommended that MEA 210 be taken concurrently.
GEP Natural Sciences
Typically offered in Fall, Spring, and Summer

MEA 202 Geology II: Historical (3 credit hours)
The second semester of the basic introductory sequence in geology. Utilization of the principles of geology to reconstruct and understand the earth's history. Geologic events that cause modification of the earth's crust, emphasizing North America. History of life and the environmental significance of changes in animal and plant life through geologic time.

Prerequisite: (MEA 100, MEA 101, MEA 120, MEA 140 or MEA 200)and MEA 110; Corequisite: Recommended that MEA 211 be taken concurrently
GEP Natural Sciences
Typically offered in Spring only

MEA 210 Oceanography Lab (1 credit hours)
Complements the lecture course in Oceanography. Numerous demonstrations and resource materials visualize basic oceanographic concepts such as geological processes operating in the marine realm, the chemical properties of seawater, oceanic circulation, tides and waves, as well as processes affecting the biology of the oceans.

Corequisite: MEA 200
GEP Natural Sciences
Typically offered in Fall, Spring, and Summer

MEA 211 Geology II Laboratory (1 credit hours)
Reconstruction and interpretation of events in the history of the earth. Interpretation of sedimentary rocks, construction and interpretation of geological maps, identification of fossil organisms and utilization of fossils in the reconstruction of earth history.

Corequisite: MEA 202
GEP Natural Sciences
Typically offered in Spring only

MEA 215 Introduction to Atmospheric Sciences (4 credit hours)
Introduction to the Earth's atmosphere. Fundamental concepts and applications of meteorology and how they relate to daily and seasonal weather, major types of storms, and climate.

Corequisite: MA 141
Typically offered in Spring only

MEA 217 Introduction to Computing in the Geosciences (3 credit hours)
This course is for students with little or no programming experience. It provides students with programming and problem solving skills using MATLAB with emphasis on the systematic development of algorithms and programs. Topics include Boolean math, data representation and types (array, vectors, strings, structures), evaluation of expressions, program control (iteration, functions), algorithm development (pseudo code, physical problem solving, numerical algorithms), basic MATLAB graphics, and limits of computing. Problems and projects are selected from the Geosciences. Students are expected to be proficient in solving algebraic equations, solving non-calculus Physics problems, including dimensional analysis, and operating a computer.

Typically offered in Fall only

MEA 220 Marine Biology (3 credit hours)
Introduction to marine plants and animals, their adaptations to life in the sea and ecological interactions in selected marine environments (e.g. coral reefs, deep sea, salt marshes). Interactions of man with the sea: food from the seas, biology of diving.

Prerequisite: MEA 200 or BIO 181
GEP Natural Sciences
Typically offered in Fall and Spring

MEA 240 The Planets of Our Solar System (3 credit hours)
This course will cover the formation mechanisms, physical properties, and processes of the vast array of bodies that compose our Solar System, and how they compare and contrast with our own world. Among the diverse range of topics we will explore are planetary formation, volcanism of Mars, the deep oceans of Jupiter's icy moons, the atmosphere of Venus, and the fate of our Sun. We will also focus on what other planetary bodies can tell us of the early and future Earth, as well as the conditions required for planetary habitability. Finally, we will consider the exciting field of exoplanet research, including the search for extraterrestrial intelligence, and discuss key milestones in the exploration of the Solar System. Delivered through lectures, in-class discussion, and associated reading, the course will be assessed through a series of quizzes, an essay, a group project, and two mid-term exams and a final exam.

GEP Natural Sciences
Typically offered in Fall only

MEA 250 Introduction to Coastal Environments (3 credit hours)
A global survey of coastal habitats, the processes that shape these dynamic environments, and the physicochemical controls that regulate their indigenous biological communities.

Prerequisite: MEA 200/210 or MEA 101/110
GEP Natural Sciences
Typically offered in Spring only

MEA 251 Introduction to Coastal Environments Laboratory (1 credit hours)
Complements the lecture course Introduction to Coastal Environments (MEA 250). Experiments involving the physical, chemical and geological properties of seawater and their effect on biological communities in the coastal marine environment. Hands-on and data science activities develop students' marine science data analysis, visualization, and presentation skills.

C: MEA 250; P: MEA 200 and MEA 210
Typically offered in Spring only

MEA 252 Biology of Marine Mammals (3 credit hours)
Biology of marine mammals, including cetaceans, pinnipeds, sirenians and sea otters. Topics covered include the evolution, physiology, behavior and ecology of marine mammals. We will focus on current topics in conservation and management of marine mammals. Instructor permission required.

Typically offered in Spring only

MEA 257 Visualizing Geology in 3D & 4D (1 credit hours)
MEA 257 will provide students with a strong foundation of essential spatial visualization skills needed to successfully complete courses in the geology curriculum. Students will be guided to complete activities that require them to create and interpret a variety of geological visualizations including maps, cross-sections, physical models, three-dimensional figures, and Google Earth images.

P: MEA 110 and either MEA 101 or MEA 100
Typically offered in Spring only

MEA 260 Human Dimensions of Climate Change (3 credit hours)
Climate is changing with potentially catastrophic implications for the Earth and for people. In this course we discuss how and why climate is changing and how climate change is affecting and will affect human well-being in society. We draw upon the multiple disciplinary lenses and diverse perspectives needed to evaluate, across multiple dimensions, proposed solutions to climate change and/or to assess fully the consequences of inaction.

GEP Interdisciplinary Perspectives
Typically offered in Fall only

MEA 300 Environmental Geology (4 credit hours)
Geologic aspects of the environment. Effects of humans upon or interactions with geologic processes. Geologic considerations in land use planning, waste disposal, water resources, and natural resources. A field and lab oriented course with combined lecture/laboratory. Inquiry-based learning approach to study the basic processes of environmental geology and develop research skills. Required field trips.

Prerequisite: MEA 101 or MEA 150 or MEA 140 or SSC 200
Typically offered in Spring only

MEA 305 Catastrophic Earth (3 credit hours)
The planet we share, Earth, sustains us, but despite the wonder of its fauna, flora, oceans, landforms and protective atmospheric blanket it can be a dangerous place. Human history, a mere 200,000 years of the Earth's history, has been characterized by major catastrophic events. These events have been driven by external energy sources (e.g. comet strike) as well as internal sources (e.g. volcanic eruption). However, now during what we call the Anthropocene, the current age of humans in geologic time, human activity is playing a dominant role as a determinant of Earth's climate. Catastrophic Earth is your introduction to major events that have shaped our planet, the survival of Earth's fauna and flora and potentially the survival of our species. During the course you will have an opportunity to explore the forces that define these events and explore alternative histories and perhaps alternative futures for our planet and species.

Typically offered in Spring only

MEA 312 Atmospheric Thermodynamics (4 credit hours)
Introduction to atmospheric thermodynamics for meteorology majors. Topics include the equation of state for mixture of gases; first and second laws of thermodynamics; diabatic and adiabatic processes for dry and moist air; measurement and phase changes of water vapor. Atmospheric statics: static stability of moist air; CAPE and vertical acceleration. Focus will be on applying the rigorous framework of classical thermodynamics to derive and solve quantitatively the governing equations describing these processes.

Prerequisite: MA 141, PY 205; Corequisite: MA 241
Typically offered in Spring only

MEA 315/MA 315 Mathematics Methods in Atmospheric Sciences (4 credit hours)
For sophomore meteorology and marine science students. A complement to MA 242 designed to prepare students for quantitative atmospheric applications. Topics include an introduction to vectors and vector calculus, atmospheric waves, phase and group velocity, perturbation analysis, fourier decomposition, matrix operations, chaos and predictability. For MY, MMY, and MRM majors only.

Prerequisite: MEA 217 or MA 116 or CSC 113; Corequisite: MA 242
Typically offered in Spring only

MEA 320/ET 320 Fundamentals of Air Pollution (3 credit hours)
Students will learn fundamental concepts in air pollution and the application of those concepts for compliance with air quality regulations. Topics include air pollutants, their properties, how they are emitted, and relevant atmospheric chemistry and physics processes, National Ambient Air Quality Standards (NAAQS) and how compliance with those regulations is maintained.

Prerequisite: MA 121 or MA 131 or MA 141, CH 101/102, PY 131 or PY 201 or PY 205 or PY 211; Recommended: CH 220/222 or CH 221/222
Typically offered in Spring only

MEA 321 Fundamentals of Air Quality and Climate Change (3 credit hours)
An intermediate-level introduction, for meteorology majors, to the physical and chemical environment of the atmosphere and to climate change. Topics include the atmosphere's chemical composition; atmospheric chemical reaction processes in gas phase, liquid phase, and on particle surfaces

Prerequisite: Two semesters of chemistry (CH 101 and {CH 201, CH 220, or CH 221}), MA 141, MA 241; Corequisite: PY 205
Typically offered in Fall only

MEA 323 Geochemistry of Natural Waters (3 credit hours)
Biogeochemical processes related to water in the natural environment. Course focuses on chemical equilbria and kinetics of: precipitation and dissolution, acid-base chemistry and the carbonate system, oxidation-reduction chemistry, and organic geochemistry in lakes, rivers, estuaries, and oceans. Topics revolve around water quality and global change. Course includes in class field sampling and lab work as well as a mandatory Saturday field trip.

Restriction: MEA and ENE Majors Only. Other Majors With Permission of Instructor; Prerequisite: CH 201 or CH 203
Typically offered in Fall and Spring

MEA 350 Marine Conservation Biology (3 credit hours)
This course will focus on the field of marine conservation, including the scientific, regulatory, social and economic factors that must be considered when trying to solve complex conservation issues. Important concepts will include: (i) sampling and experimental design, (ii) modern definitions of conservation, scientific areas of expertise in conservation, (iii) priority threats to biodiversity, (iv) laws which govern conservation in the US and internationally, and (v) social and economic considerations. The class will include presentation and critical evaluation of global, regional and local case studies marine conservation actions. Optional Friday field trips. Instructor permission required.

Typically offered in Spring only

MEA 369 Life on Earth: Principles of Paleontology (3 credit hours)
This class offers an interdisciplinary introduction to the history of life on Earth and the principles of paleontology that allow for its study and application. Key topics include: fossil records and description, evolution and extinction, paleoecology and biostratigraphy, field/lab methods, and a survey of major life forms from the early Earth through the present. This course is a learning-centered program aimed at students interested in past life and using paleontology as a tool for examining the natural world. Required field trips.

Prerequisite: BIO 181 or MEA 202
Typically offered in Spring only
This course is offered alternate odd years

MEA 370 Invertebrate Paleontology (3 credit hours)
Most of our fossil record consists of shelled animals without a backbone. These fossils provide a wealth of information about the history of life on Earth. This course will introduce you to the major invertebrate fossil groups, as well as demonstrate how scientists use these fossils to study evolution, ecology, and environmental change in deep-time.

Prerequisite: BIO 181 or MEA 202
Typically offered in Fall only

MEA 409 Watershed Forensics (3 credit hours)
Spatial analysis of watersheds with emphasis on pollution and controversies concerning water quality and regulation issues. GIS exercises will introduce students to the latest spatial analytical techniques. Case studies and lectures will be used to examine common watershed contaminates.

Prerequisite: GIS 280
Typically offered in Fall only

MEA 410 Introduction to Mineralogy (3 credit hours)
Introduction to the basics of Mineralogy (crystallography, morphology, crystallochemistry, optics, and systematics), with an emphasis on mineral identification both at the macro (hand sample) and micro (thin section) scale. Required field trip to the North Carolina Museum of Natural Sciences. Transportation is not provided.

Prerequisite: (MEA 100, MEA 101, or MEA 200), and MEA 110 and CH 101/102
Typically offered in Fall only

MEA 411 Marine Sediment Transport (3 credit hours)
Quantitative study of sediment transport in the marine environment including an introduction to fluid mechanics and sediment transport theory. Discussion of the processes and products of sediment transport in specific marine environments from estuaries to the deep sea and interpretation of sediment transport processes from sedimentary structures. Credit not allowed for both MEA 411 and MEA 562

Prerequisite: MEA 101 or MEA 200, MA 241, PY 201 or PY 205
Typically offered in Fall only

MEA 412 Atmospheric Physics (3 credit hours)
Physical and analytical descriptions of atmospheric aerosols, clouds/fogs, and precipitation processes; size distribution and sources of atmospheric aerosols; impact of aerosols on visibility and climate; microstructure of warm and cold clouds and their interaction with solar and terrestrial radiation; collision-coalescence and ice phase mechanisms of precipitation formation; atmospheric electricity; planned and inadvertent weather modification; weather radar; atmospheric optics.

Prerequisite: MA 242, PY 205
Typically offered in Spring only

MEA 415/MEA 515 Climate Dynamics (3 credit hours)
A comprehensive look at climate integrated across terrestrial, marine, and atmospheric perspectives. Topics include an in-depth look at climate proxies, drivers of future, current and past climate change, climate monitoring approaches, and climate model projections. Students will be exposed to the quantitative aspects (chemistry, physics, theory, observations, models) scientists use to place constraints on climate conditions over broad spatial and temporal scales. MEA 415 is open to upper-level undergraduate science majors interested in learning more about Earth's climate systems and the dynamics within. MEA 515 is open to all graduate students with the expectation of an additional climate assessment course project relevant to the student's own research discipline. Students cannot receive credit for both MEA 415 and MEA 515.

Prerequisite: MA 121 or MA 131 or MA 141 and CH 101 or CH 103 and PY 201 or PY 205 or PY 211
Typically offered in Fall only
This course is offered alternate even years

MEA 421 Atmospheric Dynamics I (3 credit hours)
Meteorological applications of fluid kinematics: divergence, vorticity, deformation, advection, mass continuity and vertical motion. Atmospheric dynamics: the equation of motion on a rotating earth; component equations in Cartesian, polar-sphericaland pressure coordinates. Scale analysis and simplifications. Cases of horizontal flow: geostrophic and gradient wind, ageostrophy and acceleration; thermal wind and vorticity.

Prerequisite: MA 242 and PY 205 and MEA 312
Typically offered in Fall only

MEA 422 Atmospheric Dynamics II (3 credit hours)
Vorticity and potential vorticity equations; dynamics of synoptic-scale motions; quasi-geostrophic theory; atmospheric waves including shallow water, internal gravity, inertia-gravity, and Rossby waves; finite difference methods; numerical weather prediction; atmospheric instabilities including static, Kelvin-Helmholtz, inertial, symmetric, barotropic, and baroclinic instabilities.

Prerequisite: MEA 421
Typically offered in Spring only

MEA 425/MEA 525 Introduction to Atmospheric Chemistry (3 credit hours)
The course covers history, regulations, sources, physics, and chemistry of major air pollutants and factors affecting their transport and fate. Emphasis is placed on atmospheric chemistry and physics underlying five major air pollutant problems including urban outdoor air pollution, indoor air pollution, acid deposition, stratospheric ozone reduction, and global climate change. Credit will not be allowed for MEA 425 and MEA 525.

Prerequisite: MA 141, CH 201, (PY 205, PY 211 or MEA 320)
Typically offered in Fall, Spring, and Summer
This course is offered every third semester

MEA 440 Igneous and Metamorphic Petrology (3 credit hours)
The study of rocks formed by the crystallization of magmas (igneous) and by the recrystallization of existing rocks (metamorphic), with emphasis on whole-rock and mineral compositions, classification, petrography, hand-sample and thin-section identification, and the rock origins in terms of magma genesis and emplacement and tectonics.

Prerequisite: MEA 410
Typically offered in Spring only

MEA 443 Synoptic Weather Analysis and Forecasting (4 credit hours)
Analysis and forecasting of mid-latitude weather systems with emphasis on simplified models and methods. Barotropic model, Rossby waves; baroclinic structure, upper-level wave evolution, forecasting; surface cyclone evolution, Sutcliffe-Petterssen model. Numerical computation methods; numerical weather prediction and operational models, subjective and objective analysis of meteorological fields.

Prerequisite: MEA 421
Typically offered in Fall only

MEA 444 Mesoscale Analysis and Forecasting (4 credit hours)
Analysis and forecasting of mid-latitude weather systems with emphasis on mesoscale phenomena. Definition of the mesoscale, approximations to the governing equations, basic measurements and techniques; observations, basic governing dynamics, and forecasting of mesoscale phenomena, including drylines, low-level jets, conditional symmetric instability, crographically-induced circulations, thunderstorms, mesoscale convective, and severe convective weather.

Prerequisite: MEA 443
Typically offered in Spring only

MEA 449/MEA 549 Principles of Biological Oceanography (3 credit hours)
Environmental dependencies, biological productivity, and trophic relationships in plankton, nekton and benthos; Sampling methods and experimental design; Human impacts on marine systems.Credit is not allowed for both MEA 449 and MEA(ZO)549.

Typically offered in Fall only

MEA 450 Introductory Sedimentology and Stratigraphy (4 credit hours)
Properties and classification of sediments and sedimentary rocks, geologic occurrences and origin of minerals and rocks formed by physical, chemical, and biologic processes at and near the Earth's surface. Principles of the division of stratified terrains into natural units, the correlation of strata and associated data, the interpretation of depositional environments, facies, and sequences, description of burial histories, and sedimentary basin analysis. Required field trips.

Prerequisite: MEA 410
Typically offered in Spring only

MEA 451 Structural Geology (4 credit hours)
Basic principles of geometric, kinematic and dynamic analysis as applied to fractures, shear zones, folds, and fabrics of deformed rock bodies. Considers both brittle and ductile realms of the crust from microscale to regional tectonics. Required overnight field trips.

Prerequisite: MEA 410
Typically offered in Fall only

MEA 454/MEA 554 Marine Physical-Biological Interactions (3 credit hours)
Space-time relationships between physics and biology; influence of Reynolds Number on aquatic life style; aspects of physical and biological mathematical modeling; influence of biology on physical phenomena; influence of static physical/chemical properties on biology; influence of dynamic physical phenomena (turbulence, waves and advection) on biology within the water column and its boundaries. Credit is not allowed for both MEA454 and 554

Prerequisite: MEA 460 and MEA/ZO 449
Typically offered in Spring only
This course is offered alternate even years

MEA 455 Micrometeorology (3 credit hours)
Energy budget near the earth's surface; soil temperatures and heat transfer; air temperature, humidity, and wind distribution in the planetary boundary layer; fundamentals of viscous flows and turbulence; semiempirical theories of turbulence; exchanges of momentum, heat and moisture in the atmospheric surface layer; air modification due to changes in surface properties; agricultural and forest micrometeorology.

Prerequisite: MEA 422 or MAE 308
Typically offered in Fall only

MEA 458 Introduction to Tropical Meteorology (3 credit hours)
Introduction to tropical meteorology using phenomenological examples. Thermodynamic structure of the mean tropical atmosphere, Hadley circulation, equatorial waves and the Madden Julian oscillation, El Nino-Southern oscillation, monsoons and tropical cyclones. Meteorology majors only. Meteorology majors only.

Prerequisite: MEA 422
Typically offered in Fall only
This course is offered alternate odd years

MEA 459 Field Investigation of Coastal Processes (5 credit hours)
Coastal zone processes and dynamics with emphasis on the forcing factors that regulate changing coastal landforms, the ecology and physicochemical character of coastal ocean water-masses, seabed morphologies, landscape academes, etc. Field observations and field techniques will be emphasized in tidal-freshwater coastal wetlands, estuaries, barrier island, tidal inlets, continental shelves and shelf-margin habitats. Additional fees required.

Prerequisite: MEA 250
Typically offered in Summer only

MEA 460 Principles of Physical Oceanography (3 credit hours)
Introduction to principles and practices of physical oceanography. Equation of state of seawater; energy transfer to the ocean by thermal, radiative and mechanical processes; the heat budget; oceanic density distribution; oceanic boundary conditions; conservations equation; air-sea interaction; global fluxes and general description of major ocean currents. Credit is not allowed for both MEA 460 and MEA 540

Prerequisite: MA 241 or MA 231; Corequisite: PY 203,PY 208 or PY 212.
Typically offered in Fall only

MEA 462 Observational Methods and Data Analysis in Marine Physics (3 credit hours)
Practical experience in the observational techniques used by physical oceanographers. Basic instrumentation described, emphasizing principles rather than detailed descriptions. Both direct and indirect techniques used to define the three-dimensionalcirculation of the ocean as a function of time.

Prerequisite: MEA 460
Typically offered in Spring only

MEA 463 Fluid Physics (3 credit hours)
A derivation of the basic equations governing fluid motion in a rotating coordinate system. Equations include conservation of mass or the continuity equation, momentum equations, thermodynamic energy equation and the vorticity equation. Application of equations to simplified oceanic flows which include surface gravity waves, inertial motion, geostrophic motion, Ekman dynamics and vorticity dynamics.

Prerequisite: MA 341 and PY 208
Typically offered in Fall only

MEA 464 Ocean Circulation Systems (3 credit hours)
Dynamical processes governing ocean circulation. Driving of ocean currents by the atmosphere, currents on a rotating spherical earth. Mid-ocean gyre, western boundary currents, equatorial current systems, and polar circulation. Currents in coastal regions and shallow-water processes.

Prerequisite: MEA 460
Typically offered in Spring only

MEA 465 Geologic Field Camp (4 credit hours)
Introduction to field instruments and techniques used in geological sciences. Geologic field mapping in areas ranging from undeformed sedimentary rocks to complexly deformed crystalline rocks. May include field techniques specific to engineering geology, geophysics, hydrogeology, and paleontology. Preparation of maps and reports. Four-week course taught off-campus, typically out-of-state. Additional fees required.

Prerequisite: MEA 450 and MEA 451
Typically offered in Summer only

MEA 466 Preparatory Course for Field Camp (1 credit hours)
Introduction to theory, instruments, and techniques used in MEA 465 geologic field camp. Geologic context of the area where field camp will be held. Students will supply their own graph paper for a map cross-section exercise. Credit for this course cannot be used to fulfill elective credits in any Geology curricula.

Typically offered in Spring only
This course is offered alternate odd years

MEA 467 Marine Meteorology (3 credit hours)
Basic equation and concepts. Review of ocean and atmospheric circulations. Ocean mixed layer, air-sea interaction and coastal ocean and meteorological processes, marine boundary layer and cloud processes.

Prerequisite: MA 241 and PY 205
Typically offered in Spring only

MEA 468/MEA 568 Aquatic Microbiology (3 credit hours)
Aquatic microbes are key drivers of biogeochemistry on Earth. They also influence the 'health' of valuable ecosystems, e.g. estuaries, coasts, lakes, as well as, larger organisms (e.g. shellfish, humans). In this course, multiple facets of aquatic microbiology will be covered, including (not limited to): population diversity, spatial and temporal dynamics, sampling methodologies, metabolisms, and their environmental and societal importance. A primary goal for this course is for students to be exposed to key paradigms and current challenges within the field of aquatic microbiology, but also a general perspective on how aquatic microbes thrive in nature. Although largely a classroom-based course, select class periods will be devoted to hands-on activities and/or measurements providing students with methodological experience or in-depth exposure to key topics.

Prerequisite: BIO 183
Typically offered in Fall only

MEA 469 Ecology of Coastal Resources (3 credit hours)
Anthropogenic impacts on estuarine and coastal marine ecosystems. Survey of basic biological, physical, chemical and geological mechanisms underlying habitat-specific functioning, followed by discussion, in-class presentation, and critique of real and hypothetical case studies involving anthropogenic impacts.

Prerequisite: MEA 250 and MEA 220 or MEA 449
Typically offered in Spring only
This course is offered alternate even years

MEA 470 Introduction to Geophysics (3 credit hours)
Structure of the earth, a dynamic and evolving entity, as inferred from seismology, gravity, magnetism and heat flow. Geodynamic processes responsible for continental drift; plate tectonic theory; regional geophysics of selected areas.

Prerequisite: PY 208 or 212

MEA 471 Exploration and Engineering Geophysics (3 credit hours)
Geophysical methods applied to exploring the earth's shallow sub-surface. Principles of gravity, magnetic, electrical, and seismic exploration surveys. Planning, conducting, and interpreting geophysical surveys.

Prerequisite: PY 208 or PY 211

MEA 473/MEA 573 Principles of Chemical Oceanography (3 credit hours)
Chemical processes controlling the composition of oceans, including discussions of chemical equilibria, biological cycling of nutrients and use of chemical tracers in marine environment; consideration of origin and chemical history of oceans. Creditis not allowed for both MEA 473 and MEA 573

Prerequisite: CH 201 or CH 203
Typically offered in Spring only

MEA 476 Worldwide River and Delta Systems: Their Evolution and Human Impacts (3 credit hours)
Survey of major world rivers and deltas, such as the Amazon, Mississippi, Yello, Yangtze, Mekong, Ganges-Brahmaputra, Indus, Nile, etc. Descriptions of their initiation, development, and evolution processes. Definitions of the impacts caused by climate changes and human activities. Examination of the river-ocean interactions and sedimentary and geochemical processes in terms of sea-level change, monsoon, and sediment dispersal and deposition.

Prerequisite:Senior undergraduate or Graduate standing
Typically offered in Fall only
This course is offered alternate odd years

MEA 479/CE 479 Air Quality (3 credit hours)
Introduction to: risk assessment, health effects, and regulation of air pollutants; air pollution statistics; estimation of emissions; air quality meteorology; dispersion modeling for non-reactive pollutants; chemistry and models for tropospheric ozone formation; aqueous-phase chemistry, including the "acid rain: problem; integrated assessment of air quality problems; and the fundamentals and practical aspects of commonly used air quality models. Credit is allowed only for one of CE/MEA 479 or CE/MEA 579.

CE 282 and CE 373; or CHE 311(CHE Majors); or MEA 421 (MEA Majors); Corequisite: ST 370; or ST 380 (MEA Majors)
Typically offered in Spring only

MEA 481 Geomorphology: Earth's Dynamic Surface (3 credit hours)
Landforms and the processes responsible for their origin. Emphasis on the geologic principles involved in interpreting the origin and evolution of various landforms, and discussion of North American geomorphic process.

Prerequisite: (MEA 100 or MEA 101 or MEA 200) and MEA 110
Typically offered in Spring only

MEA 485 Introduction to Hydrogeology (3 credit hours)
Basic science of groundwater flow in geological media. Saturated and unsaturated flow, Darcy's equation, heterogeneity and anisotrophy, flownets, storage properties of geological materials, effective stress, equations for steady and unsteady flow, recharge, groundwater exchange with surface water, groundwater flow to pumping wells, estimation of hydraulic properties of aquifers, contaminant plumes and chemical transport in groundwater.

Prerequisite: (MEA 101 or MEA 202), (MA 131 or MA 141), (CH 201 or CH 203), and (PY 201, PY 205, or PY 211)
Typically offered in Fall only

MEA 488 Meteorology for Media (3 credit hours)
Communication of weather and climate information with the public, including examination of communication theory, public communication of science, and geoscience communication research. Production techniques for television and digital graphics, presentation to camera, and audio recordings.

Prerequisite: One of the following ENG 331, ENG 332, ENG 333, or COM 110
Typically offered in Fall only

MEA 493 Special Topics in MEAS (1-6 credit hours)
Directed individual study or experimental course offering.

Typically offered in Fall, Spring, and Summer

MEA 495 Junior Seminar in the Marine, Earth, and Atmospheric Sciences (1 credit hours)
Emphasis on student professional development. Discussions of professional opportunities, resources, and ethics. Professionals from the public and private sectors introduce students to career options in marine, earth and atmospheric sciences. Strategies for finding jobs and graduate programs. Students reflect on future career goals and plans. For MEAS majors only.

R: MEAS Majors Only
Typically offered in Spring only

MEA 498 Internship in MEAS (1-6 credit hours)
Awards academic credit for learning that occurs during internships. Requires daily journal and written summary report. Successful completion of the course based on review of summary report by an MEAS faculty, who shall be identified by the studentprior to the internship. Transportation expenses may be incurred. MEAS majors only. Individualized/Independent Study and Research courses require a Course Agreement for Students Enrolled in Non-Standard Courses be completed by the student and faculty member prior to registration by the department.

Typically offered in Fall, Spring, and Summer

MEA 507 Discipline-based Education Research in the Geosciences (3 credit hours)
This course will prepare students to explain the conditions necessary for learning to occur in college geoscience classes; plan lessons that address geoscience literacy standards and incorporate activities that feature multiple levels of Bloom's taxonomy; describe how they would determine if student work meets defined learning goals; create effective geoscience learning environments for lecture and lab settings; analyze the teaching of others using validated instruments; and design a geoscience teaching and learning research project.

Typically offered in Spring only
This course is offered alternate odd years

MEA 510 Air Pollution Meteorology (3 credit hours)
Wind structure in atmospheric surface layer and planetary boundary layer; temperature structure and stability; mixed layer and inversions; turbulence intensity and scale; meteorological factors affecting dispersion of pollutants; diffusion theories and models; diffusion and transport experiments; plume rise, fumigation and trapping; removal processes; effects of buildings and hills; effects of local winds.

Prerequisite: MAE 308 or MEA 455 or MEA 700
Typically offered in Spring only

MEA 511 Introduction to Meteorological Remote Sensing (3 credit hours)
Meteorological remote sensing data sets used in operational forecast and research applications. Sensor physical principles. Emphasis is on understanding the strengths and weaknesses of the different types of observational data so that the student can judge adequacy of purpose for their applications.

Typically offered in Fall only

MEA 514 Advanced Physical Meteorology (3 credit hours)
Fundamental laws and concepts of thermodynamics and electromagnetic radiative transfer considered in an atmospheric context. Application of these principles to a number of meteorological problems, including radiative climate models, the global energy balance, atmospheric aerosols, lidar/radar backscatter and remotely sensed temperature fields.

Prerequisite: MEA 412, MEA 421
Typically offered in Fall only

MEA 515/MEA 415 Climate Dynamics (3 credit hours)
A comprehensive look at climate integrated across terrestrial, marine, and atmospheric perspectives. Topics include an in-depth look at climate proxies, drivers of future, current and past climate change, climate monitoring approaches, and climate model projections. Students will be exposed to the quantitative aspects (chemistry, physics, theory, observations, models) scientists use to place constraints on climate conditions over broad spatial and temporal scales. MEA 415 is open to upper-level undergraduate science majors interested in learning more about Earth's climate systems and the dynamics within. MEA 515 is open to all graduate students with the expectation of an additional climate assessment course project relevant to the student's own research discipline. Students cannot receive credit for both MEA 415 and MEA 515.

Prerequisite: MA 121 or MA 131 or MA 141 and CH 101 or CH 103 and PY 201 or PY 205 or PY 211
Typically offered in Fall only
This course is offered alternate even years

MEA 516 Climate Risk Analysis (3 credit hours)
Prepares students to analyze climate data for decision making under uncertainties in climate conditions and projections. Diverse observational and model generated climate data sets are considered. For observed data, the assumptions and statistical methods used to assess trends are explored and critically analyzed. Subsequent course work focuses on spatial analyses of climate-related anomalies and trends and on ensemble predictions, including their application to climate sensitive systems. Students become proficient in the visualization of climate information. This course requires permission from the instructor to join.

Prerequisites: MEA 517 (or equivalent), ST 305 (or equivalent) or MA 141 (or equivalent)
Typically offered in Spring only

MEA 517 Fundamentals of Climate Change Science (3 credit hours)
This course will present the basic science of climate change, including chemical and physical systems and processes. The students will be introduced to how the climate system works and the role of greenhouse gases in the climate system. Students will learn about climatological data, climate models and how predictions/projections are made. Emphasis will be placed upon relating predicted/projected changes to manifestations such as sea level rise and changes in the distribution and character of precipitation. Topics include the primary climate components, ocean-atmospheric teleconnections, decadal and multi-decadal climate indices, natural and anthropogenic climate variability, and climate model projections.

Prerequisite: Graduate standing
Typically offered in Fall only

MEA 518 Adaptation to Climate Change (3 credit hours)
Climate Adaptation investigates the technological, economic, communication, scientific and legal challenges inherent to adaptation to climate change. This course provides practical hands-on experience for professionals in developing adaptation strategies in climate sensitive sectors. Content draws heavily on case studies in international development, infrastructure, health, energy, and transportation sectors.

Prerequisites: MEA 517 or permission from instructor
Typically offered in Spring only

MEA 519 Barriers to Climate Change Literacy (3 credit hours)
Investigates the discipline-based geoscience education lenses of the cognitive, affective, and behavioral barriers to climate literacy and the practical interventions for addressing them. Critically analyzes key aspects of climate science, common misconceptions, mental models, cultural influences, and risk perceptions about climate change. Students engage with the public and design projects for overcoming barriers to climate change literacy. The course features relevant readings, classroom discussions, student peer-review, and summative and formative course feedback though course assignments and exams. Minimum of 50% seats reserved for Climate Change and Society Certificate program students.

Prerequisite: Graduate standing
Typically offered in Fall only

MEA 525/MEA 425 Introduction to Atmospheric Chemistry (3 credit hours)
The course covers history, regulations, sources, physics, and chemistry of major air pollutants and factors affecting their transport and fate. Emphasis is placed on atmospheric chemistry and physics underlying five major air pollutant problems including urban outdoor air pollution, indoor air pollution, acid deposition, stratospheric ozone reduction, and global climate change. Credit will not be allowed for MEA 425 and MEA 525.

Prerequisite: MA 141, CH 201, (PY 205, PY 211 or MEA 320)
Typically offered in Spring only
This course is offered every third semester

MEA 540 Principles of Physical Oceanography (3 credit hours)
Introduction to principles and practice of physical oceanography. The equation of state of seawater; energy transfer to the ocean by thermal, radiative and mechanical processes; the heat budget; oceanic boundary conditions; geographical distributionof oceanic properties; observational methods; conservation equations; simple waves and tides; physical oceanography of North Carolina coastal zone. Application of Fourier analysis techniques to interpretation of low-frequency motions in ocean and atmosphere. Review of Fourier method. Filtering of tidal signals. Spectral estimates and calculation of current ellipses. Identification of coherent motions and their empirical orthogonal modes. Data from field experiments used in lectures and homeworkassignments. Credit is not allowed for both MEA 460 and MEA 540

Prerequisite: MA 231 and PY 212
Typically offered in Fall only

MEA 549/MEA 449 Principles of Biological Oceanography (3 credit hours)
Environmental dependencies, biological productivity, and trophic relationships in plankton, nekton and benthos; Sampling methods and experimental design; Human impacts on marine systems.Credit is not allowed for both MEA 449 and MEA(ZO)549.

Typically offered in Fall only

MEA 553 Estuarine Biogeochemistry (3 credit hours)
Biogeochemical cycles of carbon, nitrogen, and phosphorus in coastal rivers and estuaries with selected topics on the origin, physics, and chemistry of estuarine waters and sediments. Emphasis is placed on organic matter and nutrient cycling in estuaries within the context of anthropogenic effects and climate change.

Typically offered in Spring only
This course is offered alternate even years

MEA 554/MEA 454 Marine Physical-Biological Interactions (3 credit hours)
Space-time relationships between physics and biology; influence of Reynolds Number on aquatic life style; aspects of physical and biological mathematical modeling; influence of biology on physical phenomena; influence of static physical/chemical properties on biology; influence of dynamic physical phenomena (turbulence, waves and advection) on biology within the water column and its boundaries. Credit is not allowed for both MEA454 and 554

Prerequisite: MEA 460 and MEA/ZO 449
Typically offered in Spring only
This course is offered alternate even years

MEA 562 Marine Sediment Transport (3 credit hours)
Quantitative study of sediment transportation in the marine environment including introduction to fluid mechanics and sediment transportation theory. Processes and products of sediment transportation in specific marine environments from estuaries todeep sea and the interpretation of sediment transport processes from sedimentary structures. Credit not allowed for both MEA 411 and MEA 562

Prerequisite: MEA 101 or MEA 200, MA 241, PY 201 or PY 205
Typically offered in Fall only

MEA 568/MEA 468 Aquatic Microbiology (3 credit hours)
Aquatic microbes are key drivers of biogeochemistry on Earth. They also influence the 'health' of valuable ecosystems, e.g. estuaries, coasts, lakes, as well as, larger organisms (e.g. shellfish, humans). In this course, multiple facets of aquatic microbiology will be covered, including (not limited to): population diversity, spatial and temporal dynamics, sampling methodologies, metabolisms, and their environmental and societal importance. A primary goal for this course is for students to be exposed to key paradigms and current challenges within the field of aquatic microbiology, but also a general perspective on how aquatic microbes thrive in nature. Although largely a classroom-based course, select class periods will be devoted to hands-on activities and/or measurements providing students with methodological experience or in-depth exposure to key topics.

Prerequisite: BIO 183
Typically offered in Fall only

MEA 570 Geological Oceanography (3 credit hours)
A comprehensive overview of the geological aspects of oceanography. Topics include: a) marine geophysics and the evolution of ocean basins, b) sedimentological processes and the formation of marine deposits, c) marine geochemistry and authigenic sedimentation, d) paleoceanography and the interpretation of marine stratigraphy.

Typically offered in Spring only
This course is offered alternate odd years

MEA 573/MEA 473 Principles of Chemical Oceanography (3 credit hours)
Chemical processes controlling the composition of oceans, including discussions of chemical equilibria, biological cycling of nutrients and use of chemical tracers in marine environment; consideration of origin and chemical history of oceans. Creditis not allowed for both MEA 473 and MEA 573

Prerequisite: CH 201 or CH 203
Typically offered in Spring only

MEA 574 Advanced Igneous Petrology (3 credit hours)
Physicochemical principles related to igneous petrogenesis. General principles and specific problems including origin, differentiation and emplacement of magmas and the possible relationships of igneous processes to global tectonics.

Prerequisite: MEA 440
Typically offered in Spring only
This course is offered alternate years

MEA 577 Electron Microprobe Analysis of Geologic Material (2 credit hours)
Theory of quantitative analysis of geologic material by electron beam application; laboratory operation of electron microprobe to acquire chemical composition and x-ray images of geologic material.

Prerequisite: MEA 410
Typically offered in Fall only
This course is offered alternate even years

MEA 579 Principles of Air Quality Engineering (3 credit hours)
Introduction to: risk assessment, health effects, and regulation of air pollutants; air pollution statistics; estimation of emissions; air quality meteorology; dispersion modeling for non-reactive pollutants; chemistry and models for tropospheric ozone formation; aqueous-phase chemistry, including the "acid rain" problem; integrated assessment of air quality problems; and the fundamentals and practical aspects of commonly used air quality models. Credit is allowed only for one of CE/MEA 479 or CE/MEA 579

Prerequisite: CE 373,CE 282; or CHE 311(CHE Majors); or MEA 421(MEA Majors), Corequisite: ST 370; ST 380(MEA Majors)
Typically offered in Spring only

MEA 580 Air Quality Modeling and Forecasting (4 credit hours)
Topics include numerical solutions to ODEs/PDEs, atmospheric chemistry, cloud and aerosol microphysics, emission modeling, meteorological modeling, and model design, applications, and evaluation. It is targeted for students who would like to learn about air quality modeling and who are prospective air quality model users.

Prerequisite: CSC 112, MEA 425/525, CE 479/579
Typically offered in Fall and Spring

MEA 581/CE 581 Fluid Mechanics in Natural Environments (3 credit hours)
Free surface flows of water and air occurring in natural fluid systems and influencing environmental transport and mixing. Review of fundamental principles of fluids, covering the scales relevant to both engineering and geo-physical applications. Topics and examples include waves, instability, stratification, turbulent boundary layers, jets and plumes, and open channel flows. Cannot receive credit for both CE 581 and MEA 581.

Prerequisite: CE 282 or MEA 463 or permission of instructor
Typically offered in Fall only

MEA 582/GIS 582 Geospatial Modeling (3 credit hours)
The course provides foundations in methods for GIS-based surface analysis and modeling. The topics include proximity analysis with cost surfaces and least cost paths, multivariate spatial interpolation and 3D surface visualization. Special focus is on terrain modeling, geomorphometry, solar irradiation, visibility, and watershed analysis. Students are also introduced to the basic concepts of landscape process modeling with GIS and to the principles of open source GIS. Introductory level knowledge of GIS or surveying/ geomatics principles is required.

Typically offered in Fall and Spring

MEA 584/GIS 584 Mapping and Analysis Using UAS (3 credit hours)
The course provides an overview of UAS mapping technology and its rules and regulations. The principles of UAS data collection are explained along with optional hands-on practice with in flight planning and execution. The main focus is on processing imagery collected from UAS using structure from motion techniques and deriving orthophoto mosaics and ultra-high resolution digital elevation models of land surface, vegetation and structures. More advanced topics include multi-temporal 3D data analysis, fusion with lidar data and 3D visualization.

Prerequisite: GIS 510 or GIS/MEA 582 or Permission of Instructor
Typically offered in Summer only

MEA 585 Physical Hydrogeology (3 credit hours)
Physical aspects of groundwater flow in geological media. Saturated and unsaturated flow, Darcy's equation, heterogeneity and anisotropy, storage properties of geological materials, effective stress, governing equations for steady and unsteady flow, recharge, groundwater exchange with surface water, groundwater flow to well,s estimation of hydraulic properties of aquifers.

Prerequisite: MEA 101, MEA 110, MA 241, and PY 201 or PY 205
Typically offered in Spring only
This course is offered alternate years

MEA 591 Special Topics in Marine Science (1-6 credit hours)
Opportunity for advanced undergraduate and graduate students to study timely special problem areas in Marine Science and Engineering

Typically offered in Fall, Spring, and Summer

MEA 592 Special Topics in Earth Sciences (1-6 credit hours)
Special topics in earth sciences, provided to groups or to individuals.

Typically offered in Fall, Spring, and Summer

MEA 593 Special Topics in Atmospheric Science (1-6 credit hours)
Special topics in atmospheric science, provided to groups or to individuals.

Typically offered in Fall, Spring, and Summer

MEA 599 Regional Geology of North America (1-6 credit hours)
Field study of classic geologic localities and geomorphic processes not indigenous to North Carolina. Typical areas: New England and adjacent Canada, northern Mexico and southwestern United States and Pacific Northwest. Representative subjects include Canadian Shield, Precambrian mineral deposits, San Andreas fault, desert geomorphology, Grand Canyon stratigraphy, modern and ancient reefs and glaciated volcanoes. Mineral, rock and fossil collecting. Required student reports.

Prerequisite: MEA 101 or MEA 120, Senior standing
Typically offered in Fall only

MEA 601 Seminar (1 credit hours)
Presentation by each student of one seminar on his/her current research.

Prerequisite: Graduate standing
Typically offered in Fall and Spring

MEA 611 Special Topics in Marine Sciences (1-6 credit hours)
Special topics in earth sciences, provided to groups or to individuals.

Typically offered in Fall, Spring, and Summer

MEA 612 Special Topics in Earth Sciences (1-6 credit hours)
Special topics in atmospheric science, provided to groups or to individuals.

Typically offered in Fall, Spring, and Summer

MEA 613 Special Topics Atmospheric Sciences (1-6 credit hours)
Typically offered in Fall and Spring

MEA 630 Independent Study (3 credit hours)
Capstone project for the Climate Change and Society program. Students will carry out research in collaboration with an on-campus or off-campus partner in a climate-related sector. Students will address a real-world climate adaptation problem or issue and will prepare a written report describing the outcome of their research.

P: MEA 516, MEA 517, MEA 518, MEA 519, GIS 510
Typically offered in Fall, Spring, and Summer

MEA 685 Master's Supervised Teaching (1-3 credit hours)
Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

Prerequisite: Master's student
Typically offered in Fall, Spring, and Summer

MEA 690 Master's Examination (1-9 credit hours)
For students in non thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

Prerequisite: Master's student
Typically offered in Fall, Spring, and Summer

MEA 693 Master's Supervised Research (1-9 credit hours)
Instruction in research and research under the mentorship of a member of the Graduate Faculty.

Prerequisite: Master's student
Typically offered in Fall and Spring

MEA 695 Master's Thesis Research (1-9 credit hours)
Thesis Research

Prerequisite: Master's Student
Typically offered in Fall, Spring, and Summer

MEA 696 Summer Thesis Research (1 credit hours)
For graduate students whose programs of work specify no formal course work during a summer session and who will be devoting full time to thesis research.

Prerequisite: Master's student
Typically offered in Summer only

MEA 699 Master's Thesis Preparation (1-9 credit hours)
For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis. Credits Arranged

Prerequisite: Master's student
Typically offered in Fall, Spring, and Summer

MEA 700 Environmental Fluid Mechanics (3 credit hours)
Basic concepts and laws governing motion of atmosphere and oceans developed from first principles, including approximations valid for environmental flows, kinematics, dynamics and thermodynamics of fluid flows as well as introduction to environmental turbulence. Credit is not allowed for both MEA 463 and MEA 700

Prerequisite: MA 241, PY 208
Typically offered in Fall only

MEA 703 Atmospheric Aerosols (3 credit hours)
An understanding of aerosols as primary air pollutants, indoor versus outdoor pollution, transformation processes, prediction of atmospheric concentrations, scavenging of aerosols, transport of air pollutants on a regional scale, discussion of national experiments to characterize and study impact of urban-industrial pollution, tropospheric aerosol and weather, stratospheric aerosol, effect of aerosols on atmospheric warming and cooling and air-quality models.

Prerequisite: (CH 201 or CH 203) and (PY 205 or PY 211), Corequisite: MEA 412
Typically offered in Spring only
This course is offered alternate years

MEA 705 Dynamic Meteorology (3 credit hours)
Brief review of classical and physical hydrodynamics; scale analysis of dynamic equations; atmospheric instabilities; dynamics of tropical convections; perturbation theory and approximations for atmospheric wave motions.

Prerequisite: MEA 422
Typically offered in Spring only

MEA 707 Planetary Boundary Layer (3 credit hours)
Review of basic equations and concepts of planetary boundary layers. The closure problem and semi-empirical theories of turbulence, buoyancy effects on mean flow and turbulence, instrumentation and observational platforms for PBL experiments, observed characteristics of atmospheric boundary layers, numerical and physical modeling of PBL and its parameterization in large-scale atmospheric circulation models.

Prerequisite: MEA 455 or MEA 721
Typically offered in Fall and Spring
This course is offered alternate years

MEA 708 Atmospheric Turbulence (3 credit hours)
Statistical description of turbulence, including probability, correlation and spectrum functions. Statistical theory of homogeneous turbulence, spectral dynamics and Kolmogorov's local similarity hypotheses. Effects of shear, thermal stratification and earth's rotation. Observed structure and scales of turbulence in PBL and free atmosphere. Higher-order closure models and large eddy simulations of atmospheric turbulence.

Prerequisite: MAE 550 or MEA 700 or MEA 707
Typically offered in Spring only
This course is offered alternate years

MEA 710 Atmospheric Dispersion (3 credit hours)
Lagrangian vs. Eulerian descriptions of turbulence and diffusion. Statistical theories of absolute and relative diffusion from continuous and instantaneous releases. Effects of shear, thermal stratification and earth's rotation on atmospheric dispersion. Lagrangian similarity theories of diffusion in the surface layer and mixed layer. Random walk, Monte Carlo and large eddy simulations of atmospheric dispersion. Urban and regional dispersion models.

Prerequisite: MAE 550 or MEA 700 or MEA 510
Typically offered in Fall only
This course is offered alternate years

MEA 712 Mesoscale Modeling (3 credit hours)
Modeling mesoscale weather phenomena including midlatitude cyclones, mesoscale convective complexes and squall lines. Application of finite difference, spectral and implicit methods and coordinate transforms to these problems. Utilization of explicit representations of moist processes. Development of parameterizations of convective clouds, planetary boundary layer and moist processes.

Prerequisite: MEA 705
Typically offered in Fall only
This course is offered alternate years

MEA 713 Mesoscale Dynamics (3 credit hours)
Inertia-gravity waves. Mechanical and thermally forced waves. Generation, circulation and maintenance of mesoscale convective storms and systems. Symmetric instability. Wave-CISK, quasi-geostrophic and semi-geostrophic fronts and fronto-genesis. Meso-B/Y frontogenesis. Lee and coastal cyclogenesis.

Prerequisite: MEA 700 and MEA 705
Typically offered in Fall only
This course is offered alternate years

MEA 714 Atmospheric Convection (3 credit hours)
Structure, physics and dynamics of convective clouds and cloud systems; fundamental equations for modeling convection; microphysical parameterization schemes; influence of instabilities on convective cloud systems; severe thunderstorms dynamics; tornadogenesis theories; mesoscale convective systems; upscale feedback effects of convection; cumulus parameterization schemes.

Prerequisite: MEA 412, MEA 700, MEA 705
Typically offered in Fall only
This course is offered alternate odd years

MEA 715 Dynamics of Mesoscale Precipitation System (3 credit hours)
Frontogenesis theory; inertial and conditional symmetric instability; mesoscale gravity waves and wave-CISK; conveyor belts; seeder-feeder processes and precipitation generating cells; classification and dynamics of precipitation band types.

Prerequisite: MEA 444
Typically offered in Fall only
This course is offered alternate even years

MEA 716 Numerical Weather Prediction (3 credit hours)
Parameterization of physical processes in atmospheric modeling, including numerous hands-on experiments to allow evaluation and analysis of process representation in models. Emphasis on experimental design: Using numerical models as a tool with which to test scientific hypotheses. Investigation of data assimilation and ensemble prediction techniques. Journal discussion and student presentations are featured prominently. A semester project allows students to apply knowledge to thesis projects, and synthesize class concepts. Some comfort level with Linux computing environment, shell scripting, and programming languages such as FORTRAN required.

Typically offered in Fall and Spring
Offered in Even Years

MEA 717 Advanced Weather Analysis (3 credit hours)
Evolution of physical and dynamic structure of synoptic and sesoscale storm systems occurring in middle and high latitudes. Recent advances in understanding these storm systems through intensive field experiments and computer modeling. Introduction to contemporary analysis techniques through laboratory exercises shedding light on storm structure, dynamics and scale interaction.

Prerequisite: MEA 444, MEA 705
Typically offered in Fall only
This course is offered alternate years

MEA 719 Climate Modeling (3 credit hours)
Climate system. Fundamental equations and time scales. Atmosphere, ocean, biosphere, cryosphere, lithosphere and hydrosphere subsystems. Computational numerical methods. Physical processes; atmosphere-ocean coupling, role of radiation, clouds and land surface processes. Climate anomalies due to changes in atmospheric composition, boundary conditions and extra-terrestrial forcing. Model validation, climate change detection, past climates and future climate scenarios.

Prerequisite: MEA 705
Typically offered in Fall only
This course is offered alternate years

MEA 721 Air-Sea Interaction (3 credit hours)
Review of basic equations and concepts of turbulent transfer in geophysical flows, air-sea interaction processes and their importance to man's activities, theory and observation of wind-generated ocean surface waves, turbulent transfers in planetaryboundary layer of marine atmosphere, oceanic mixed layer, development of thermocline and inversion.

Prerequisite: MEA 422 or MEA 560
Typically offered in Spring only
This course is offered alternate years

MEA 735 Fourier Analysis of Geophysical Data (3 credit hours)
Application of Fourier analysis to interpretation of low-frequency motions in ocean and atmosphere. Review of Fourier method. Filtering of tidal signals. Spectral estimates and calculation of current ellipses. Identification of coherent motions and their empirical orthogonal modes. Data from field experiments used in lectures and homework assignments.

Prerequisite: MA 341 and ST 511
Typically offered in Spring only
This course is offered alternate years

MEA 741 Synpotic Physical Oceanography (3 credit hours)
Basic discussion of the techniques and terminology of synoptic physical oceanography; focus on water characteristics and their relationship to currents in the individual oceans; a systematic quantitative description of the character of ocean waters and their movements.

Prerequisite: MEA 560
Typically offered in Spring only
This course is offered alternate years

MEA 743 Ocean Circulation (3 credit hours)
Basic study of mechanics of ocean circulation with emphasis on various simple models of circulation systems.

Prerequisite: MEA 700 or PY 411
Typically offered in Fall only

MEA 744 Dynamics of Shelf Circulation (3 credit hours)
Description and models of dynamic processes on the shelf, including seiches and tides in gulfs, propagation of tides and storm surges, wind-induced coastal upwelling, continental shelf waves and coastally trapped waves. Steady circulation driven by winds, river plumes and density forcing, formation of shelf-break fronts; and influence from deep-ocean currents.

Prerequisite: MEA 700
Typically offered in Fall only
This course is offered alternate years

MEA 752 Marine Plankton Ecology (3 credit hours)
Examination of worldwide relationships between physical-chemical environment and planktonic organisms. Organism descriptions; effects of light, temperature, salinity, density, water motion and chemical constituents on organisms; interactions among different organisms emphasizing competition and predation; community structure, distribution and succession; and mathematics models of distribution, production and interaction.

Prerequisite: BCH 451 and MA 121 and ZO 419
Typically offered in Fall only
This course is offered alternate years

MEA 759 Organic Geochemistry (3 credit hours)
Sources and fates of organic material in the geochemical environment. Microbial transformations of organic compounds. The use of biomarkers to study depositional environments. Petroleum, natural gas and coal formation. Extraterrestrial organic geochemistry.

Typically offered in Fall only
This course is offered alternate years

MEA 760 Biogeochemistry (3 credit hours)
Processes involved in the biogeochemical cycling of C, N, S and related biogenic elements. Stable isotopic and other geochemical signatures of biological processes. Introduction to modeling chemical distributions in sediments. The impact of biogeochemical processes on atmospheric chemistry.

Typically offered in Fall only
This course is offered alternate years

MEA 762 Marine Geochemistry (3 credit hours)
Detailed examination of chemical processes occurring in marine environment. Chemical evolution of the oceans, continental and submarine weathering, particle scavenging of reactive elements from water, column, formation of biogenic and metaliiferousdeposits, sediment diagenesis and marine geochronology.

Prerequisite: CH 331, MEA 560
Typically offered in Spring only
This course is offered alternate years

MEA 763 Isotope Geochemistry (3 credit hours)
This class offers an interdisciplinary introduction to the principles of isotope chemistry and its application to geological, atmospheric, and biological systems. Key topics include: isotope systematics; isotope measurements and analyses; common radiogenic (U, Ar, Pb, Sr, C, Be) and stable (H, O, C, N, S) isotope systems; applications to geochronology, paleobiology, paleoclimatology, environmental tracking, archeology, and more. This course is aimed at graduate students interested in using isotopes as a tool for examining the natural world.

Restriction: Graduate Standing or Permission of the Instructor
Typically offered in Fall only
This course is offered alternate years

MEA 779 Advanced Air Quality (3 credit hours)
Local, regional and global scale chemical interactions, transport and behavior of trace gases (sulfur carbon, nitrogen, hydrocarbon, and photo-chemical oxidants) in the atmosphere. covers three primary elements of air quality: anthropogenic and natural emissions of trace gases; interactions of the pollutants in the atmosphere; and monitoring and sampling of gaseous and particulate pollutants.

Prerequisite: (CH 201 or CH 203) and MEA(CE) 479
Typically offered in Spring only

MEA 785 Chemical Hydrogeology (3 credit hours)
Quantitative analysis of hydrological, geological, and geochemical factors controlling the transport and fate of organic and inorganic chemicals in groundwater. Acid-base, precipitation-dissolution, weathering, redox, complexation, sorption, and gas exchange reactions. Advection, diffusion, and dispersion in porous media, analytical solutions to the advection-dispersion equation. Non-aqueous-phase (organic) liquids.

Prerequisite: (CH 201 or CH 203) and (MEA 585 or CE 584)
Typically offered in Spring only
This course is offered alternate years

MEA 788 Advanced Structural Geology (3 credit hours)
Principles of rock mechanics and their application in solving geologic problems; finite strain analysis of deformed rocks; advanced techniques of structural analysis; petrofabrics; development of various geologic structures. Emphasis upon application of principles and techniques in the field.

Prerequisite: MEA 451
Typically offered in Fall only
This course is offered alternate years

MEA 789 Topics In Appalachian Geology (3 credit hours)
Examination of geology of areas within Appalachian orogenic belt. Lectures, discussions, reading and review of current literature and consideration of ideas concerning geological evolution of region. Required field trips.

Prerequisite: MEA 440, 450 and 451
Typically offered in Fall only
This course is offered alternate years

MEA 790 Geotectonics (3 credit hours)
In-depth examination of current ideas in plate tectonic theory. Plate tectonic controls on orogeny, orogenic belts, magmatism and metallogeny.

Prerequisite: MEA 440, 450, 451
Typically offered in Fall only
This course is offered alternate years

MEA 791 Advanced Special Topics in Marine Science (1-6 credit hours)
Opportunity for advanced undergraduate and graduate students to study timely special problem areas in Marine Science and Engineering

Typically offered in Fall, Spring, and Summer

MEA 792 Advanced Special Topics in Earth Sciences (1-6 credit hours)
Special topics in earth sciences, provided to groups or to individuals.

Typically offered in Fall, Spring, and Summer

MEA 793 Advanced Special Topics in Atmospheric Science (1-6 credit hours)
Special topics in atmospheric science, provided to groups or to individuals.

Typically offered in Fall, Spring, and Summer

MEA 796 Exploration And Engineering Geophysics (3 credit hours)
Geophysical methods as applies to exploring the earth's mineral and energy resources and to investigating subsurface geological structure and physical properties. Principles, measurements, analyses, and interpretations of gravity, magnetic, electric, electromagnetic, seismic methods. Required research paper.

Prerequisite: MEA 470 or PY 208
Typically offered in Spring only

MEA 801 Seminar (1 credit hours)
Presentation by each student of one seminar on his/her current research.

Prerequisite: Graduate standing
Typically offered in Fall and Spring

MEA 810 Special Topics (1-6 credit hours)
Typically offered in Fall, Spring, and Summer

MEA 811 Special Topics in Marine Sciences (1-6 credit hours)
Special topics in earth sciences, provided to groups or to individuals.

Typically offered in Fall, Spring, and Summer

MEA 812 Special Topics in Earth Sciences (1-6 credit hours)
Special topics in atmospheric science, provided to groups or to individuals.

Typically offered in Fall and Spring

MEA 813 Special Topics in Atmospheric Sciences (1-6 credit hours)
Special topics in earth sciences, provided to groups or to individuals.

Typically offered in Fall and Spring

MEA 885 Doctoral Supervised Teaching (1-3 credit hours)
Teaching experience under the mentorship of faculty who assist the student in planing for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

Prerequisite: Doctoral student
Typically offered in Fall and Spring

MEA 893 Doctoral Supervised Research (1-9 credit hours)
Instruction in research and research under the mentorship of a member of the Graduate Faculty.

Prerequisite: Doctoral student
Typically offered in Fall and Spring

MEA 895 Doctoral Dissertation Research (1-9 credit hours)
Dissertation Research

Typically offered in Fall, Spring, and Summer

MEA 896 Summer Dissertation Research (1 credit hours)
For graduate students whose programs of work specify no formal course work during a summer session and who will be devoting full time to thesis research.

Prerequisite: Doctoral student
Typically offered in Summer only

MEA 899 Doctoral Dissertation Preparation (1-9 credit hours)
For students who have completed all credit hour requirements, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

Prerequisite: Doctoral student
Typically offered in Fall, Spring, and Summer