Department of Ocean & Earth Sciences

406 Oceanography and Physics Building  
Norfolk, VA 23529  
757-683-4285  
www.odu.edu/oes

Fred C. Dobbs, Chair  
Richard Zimmerman, Graduate Program Director

Mission

The Department of Ocean and Earth Sciences acquires and disseminates knowledge of the earth system, including the relationships among the biological, chemical, geological, and physical components of our planet. It is critical that we understand both natural and human-induced processes that change this system so we are prepared to meet present and future challenges to our society. With curiosity, creativity, scholarship, and respect as cornerstones of our philosophy, we strive to increase scientific knowledge and literacy through excellence in research, education, and service to the Commonwealth of Virginia and society in general.

General Description of Graduate Degrees

Two graduate programs are offered:

- Master of Science, Ocean and Earth Sciences
- Doctor of Philosophy, Oceanography

The Master of Science degree has both thesis and non-thesis options. The Ph.D. degree follows the traditional path of original research in the field of oceanography. For both degree paths, areas of emphasis are biological, chemical, geological, and physical oceanography, and the earth and geological sciences. Interdisciplinary studies are emphasized and an integral part of the student experience. The curricula are designed to prepare graduates for professional practice in their area of interest. Official transcripts, 3 letters of recommendation, TOEFL scores (international students), and a statement of goals and interest for graduate study should all be submitted to the Office of Admissions by January 1 for full consideration.

The department receives support from the Commonwealth and local philanthropic sources, as well as from private industry, and considerable support from federal agencies such as the National Science Foundation. Establishment of the Virginia Graduate Marine Science consortium by the General Assembly in 1979 demonstrated the Commonwealth’s determination to achieve excellence in marine science. The purpose of the consortium is to advance marine science instruction, research, training, and advisory services and to enhance Virginia’s position in seeking funding that change this system so we are prepared to meet present and future challenges to our society. With curiosity, creativity, scholarship, and respect as cornerstones of our philosophy, we strive to increase scientific knowledge and literacy through excellence in research, education, and service to the Commonwealth of Virginia and society in general.

Graduate Certificate in Spatial Analysis of Coastal Environments

The Certificate in Spatial Analysis of Coastal Environments provides an interdisciplinary program for students wishing to pursue careers in coastal management or research, remote sensing, or applications of geographic information systems (GIS). Rendered upon completion of the requirements, the certificate is an academic affidavit comprised of courses in geography, biology, and ocean and earth, and is administered by the Department of Ocean and Earth Sciences and the Department of Political Science and Geography. Students must take courses in the areas listed below and complete them with a cumulative GPA of 3.00 or higher and no grade below a C (2.00). The certificate is available to postgraduate professionals who meet the requirements. Students with comparable professional experience may be able to show competencies in selected courses through examination.

I. Core Courses (Both courses are required)  6
   - GEOG 502  Geographic Information Systems
   - GEOG 504  Digital Techniques for Remote Sensing

II. Interpretive Analysis Courses (Select two from the following)  6
   - BIOL 504  Conservation Biology
   - GEOG 520  Marine Geography
   - GEOG 522  Coastal Geography
   - GEOG 590  Applied Cartography/GIS
   - GEOG 595  Topics in Geography
   - OEAS 551  Data Collection and Analysis in Oceanography

III. Capstone Seminar (Select one from the following)  3
   - GEOG 519  Spatial Analysis of Coastal Environments
   - OEAS 519  Spatial Analysis of Coastal Environments

Total Hours  15

Master of Science - Ocean and Earth Sciences

Richard Zimmerman, Graduate Program Director

Admission

Applicants who have obtained a bachelor’s degree in a science (e.g., biology, chemistry, geology, physics), mathematics, or engineering, with a minimum 3.00 grade point average in their major and a 2.80 overall grade point average, are eligible for regular admission to the program. At least two semesters of calculus are also required. Ocean and earth sciences is an interdisciplinary endeavor and it is expected that applicants have science courses outside their major.

For students wishing to study geological/earth sciences, an undergraduate major in geology is required for regular admission. Students wishing to study physical oceanography should have majored in physics, mathematics, engineering, computer science, meteorology or a related physical sciences. Such applicants must have completed 36 hours in one of these fields and completed mathematics through partial differential equations.

An applicant who does not meet all requirements for admission as a regular graduate student may be admitted as a provisional graduate student. Students lacking adequate preparation for the program may make up deficiencies by taking appropriate undergraduate courses.

Requirements

The student shall meet all university requirements for graduate degrees outlined in the Requirements for Graduate Degree section in this catalog, including at least 30 hours of graduate study. A maximum of 12 hours of credit may be transferred into a graduate degree program from non-degree status at Old Dominion University or from another accredited institution, except in the case of an approved inter-institutional program. All students are expected to demonstrate competency in oral communication and proficiency in writing.
At least one month prior to graduation, all incomplete grades should be cleared. An Academic Record Change form is used for this purpose, and the instructor of the course and the department chair need to sign this form.

Removal of Incompletes

MS graduate students must participate in field activities for a total of 5 days.

Non-Thesis Option

A student in the non-thesis program must pass a written comprehensive examination testing breadth of knowledge in oceanography. The examination is given twice yearly, normally in October and March. The examination grades are fail, pass, or pass with distinction. A student who has failed the examination may retake it only once.

Thesis Option

Before a student embarks on thesis research, a thesis advisory committee must be formed. Further information on university guidelines for forming this committee can be found in the Requirements for Graduate Degrees section of this catalog. The student must also submit a thesis proposal which outlines the research to be undertaken and identifies the resources required for completion of the research. Guidelines for the preparation of the thesis proposal are available from the graduate program director. Any student whose thesis research requires departmental funding must obtain prior approval from the department chair and graduate program director. No funds will be given without this approval. The thesis proposal requires the approval of the graduate program director and the student’s thesis advisory committee.

As part of the thesis requirement, the student is required to present a public defense of the research. The public defense and approval of the thesis by the student’s Thesis Committee satisfy the comprehensive examination requirement. Students in the thesis program should consult the graduate program director regarding the preparation of the M.S. thesis, scheduling a thesis defense, and the final submission of the thesis.

Ship Time Requirement and/or Field Work

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Request to Graduate

The student should complete an Application for Graduation form through the Registrar’s Office. The deadline for submitting this application is listed in the class schedule each semester and usually falls near the end of the semester preceding the one during which graduation is anticipated. It is the student’s responsibility to meet these deadlines and submit the necessary paperwork for graduation.

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Course Distribution

A minimum of 13 hours of basic course work in the four sub-disciplines of oceanography is required of all M.S. students. This core program consists of:

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Electives: 17

Courses to be approved by the student's guidance committee.

Total Hours 30

Students must achieve a grade of B or better in each of the four core courses. Students may repeat any individual core course only once; if a student fails to earn a grade of B or better on repeating a core course, then the student will be dismissed from the program.

The remaining 17 credits are chosen from a list of graduate courses approved by the student’s guidance committee. At least 60 percent of all courses must be at the 600 level or above. For the non-thesis option, up to three hours of research may be used to meet course requirements. For the thesis option, up to six hours of research may be used to meet the course requirements.

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the core courses listed above, and a minimum of 65 hours of additional
lecture courses and dissertation research, for a total of 78 credit hours.

A maximum of 12 graduate credit hours may be transferred into a graduate
degree program from non-degree status at Old Dominion University or
from another accredited institution, except in the case of an approved
interinstitutional program.

Diagnostic Examination
Although not required, the guidance committee has the option to administer
a written and oral diagnostic examination during the first semester of
residence (or before nine credit hours have been completed) for students
entering the program with an M.S. degree in oceanography. For students
matriculating with a bachelor’s degree or an M.S. degree in another field,
the optional diagnostic examination should be administered no later than
the third semester of residence (or before completion of 27 credit hours).
The diagnostic examination will be prepared by the student’s guidance
committee in consultation with the graduate program director. The results
of this examination are used as guidance for the curriculum plan. The guidance
committee may also recommend to the graduate program director, based on
the student’s performance in the four oceanography core courses, that the
diagnostic examination be waived.

Computer Language Skills
To satisfy this requirement the student must either take a course in
MATLAB programming (OEAS 595) or solve a substantial problem by
writing an original computer program. The student’s advisor in consultation
with the guidance committee develops the problem and a reasonable
timetable for its completion. The problem must be solved independently
with no help from others. The results will be evaluated by the advisor and
guidance committee who will determine whether the student has solved
the posed problem to their satisfaction. This computer language skills
requirement should be completed before taking the candidacy exam.

Ship Time and/or Fieldwork Requirement
Each student is required to have at least ten days of shipboard experience,
fieldwork, or a combination of the two.

Candidacy Exam
Near the completion of course work and before becoming heavily involved
in dissertation work, the student shall pass a candidacy examination designed
to test scholarly competence and knowledge of oceanography. The exam has
written and oral portions prepared by the guidance committee. Additional
details on the structure, form and content of the candidacy exam are
available from the graduate program director and in the Requirements for
Graduate Degrees section in this Catalog.

Formation of a Dissertation Committee
After the candidacy examination has been passed and the dissertation
committee formed, the guidance committee’s responsibilities are completed.
The dissertation committee is a new committee and is formed to supervise
the student’s dissertation research. Students should see the graduate program
director or refer to the Requirements for Graduate Degrees section in this Catalog
for further information on the formation of a dissertation committee.

Changes to the dissertation committee must be made in advance of the oral
dissertation defense. Such changes are made only with the approval of the
GPD and college dean.

Advancement to Candidacy
Advancement to candidacy is a formal step that occurs after the student has:
1. completed formal coursework;
2. passed the Ph.D. written and oral components of the candidacy
   examination; and;
3. submitted a topic that is approved by the dissertation committee chair.

The student must be advanced to candidacy at least 12 months before
the time the degree is expected to be received, but usually not before the
completion of one-and-a-half years of graduate work.

Dissertation Preparation
General regulations and procedures governing the submission of a
doc toral dissertation are given in the Guide for Preparation of Theses and
Dissertations (obtained at https://www.odu.edu/content/dam/odu/offices/
Students should read this guide carefully before beginning to write their
dissertation. Writing the dissertation as chapters that can be submitted for
publication is encouraged.

Please note that the thesis and dissertation guide in place at the start of the
semester will remain in force for the entire semester, and any changes made
to the guide over the academic year (and the dates of these changes) will
be listed on the cover page of the guide. Changes to the previous guide will
also be noted on the cover page of the guide, or in a separate document that
can be downloaded from the same site as the complete guide. For more
information on dissertation preparation and approval in the College of
Sciences, contact your graduate program director.

Dissertation Defense
The format of a dissertation defense is determined by the dissertation
committee with the approval of the GPD. The defense is chaired by the
director of the dissertation committee. The chair will act as moderator,
ruling on questions of procedure and protocol that may arise during the
defense. Students should see the graduate program director or refer to
the Requirements for Graduate Degrees section in this catalog for further
information on the format of the dissertation defense.

Satisfactory performance on this examination (oral dissertation defense)
and adherence to all regulations outlined above complete the requirements
for the Ph.D. degree. All requirements for the doctoral degree must be
completed within eight calendar years from the date of initial registration in
the program.

Dissertation Acceptance and Submission
Once the dissertation committee has approved the dissertation, the student
and major advisor must review the entire dissertation to ensure that it
adheres to the format described in the Guide for Preparation of Theses and
Dissertations before submitting the dissertation to the GPD for final review.
Ten days should be allowed for GPD review. Once the GPD has approved
the dissertation, the student submits the dissertation to the associate dean
in the College of Sciences for approval. All approvals must be completed
by the day before commencement. However, the associate dean generally
requires that all dissertations be submitted prior to this deadline. Students
should consult with the GPD for further details.

Request to Graduate
The student should obtain a copy of the form Application for Graduation
from the Registrar’s Office and complete this application. The deadline
for submitting this application is listed on the Registrar’s Office website
at www.odu.edu/registrar (http://www.odu.edu/registrar/) and usually falls
near the end of the semester preceding the one during which graduation is
anticipated. It is the student’s responsibility to meet these deadlines and
submit the necessary paperwork for graduation.

Removal of Incompletes
At least one month prior to graduation, all incomplete grades should be
cleared. An Academic Record Change form is used for this purpose, and
the instructor of the course and the department chair need to sign this form.

OCEAN AND EARTH SCIENCES Courses
OEAS 502. Field Experiences in Oceanography for Teachers. 3 Credits.
Field and laboratory experiences in oceanography including hands-on
experience using equipment and methods suitable for middle and secondary
education professionals. Course will provide understanding of oceanic
processes using simple field and laboratory experiments. Not available
for credit for OES majors and minors. Prerequisites: background in K-12
Education.
OEAS 503. Aquatic Pollution. 3 Credits.
This course will present basic ecological principles relevant to water pollution and ecotoxicology. Topics will include runoff, eutrophication, water and sewage treatment, industrial waste, oil pollution, pesticides, and plastics in the sea. Case studies provide focal points for consideration of issues in making decisions and setting policy. This is a writing intensive course.

OEAS 505. Physical Oceanography. 3 Credits.
Physics of the ocean: properties of seawater and their distribution; water mass formation; mass and energy flows; waves; tides; models; estuarine and coastal processes. An elective for science and engineering majors. Prerequisites: C or better in MATH 211 and either PHYS 232N or two semesters of hydraulics.

OEAS 506. Matlab. 1 Credit.
This course is designed to introduce students to Matlab programming and to develop skills utilizing this program for data analysis. Prerequisite: C or better in MATH 211 or permission of instructor.

OEAS 510. Chemical Oceanography. 3 Credits.
Chemical composition of the ocean and the chemical, biological, geological and physical processes controlling it.

OEAS 512. Global Environmental Change. 3 Credits.
An examination of the development of the earth as a habitable planet, from its origin to human impacts on global biogeochemical cycles on land, and in the oceans and atmosphere.

OEAS 513. Environmental Geochemistry. 3 Credits.
This course examines geochemical processes at and near the Earth’s surface, focusing on the concentration, speciation and reactivity of elements in soils, waters, sediments and the atmosphere. The course examines both the thermodynamic and kinetic controls on these processes, and the role of biology as a mediator (or facilitator) of these processes. Anthropogenic impacts on natural geochemical processes are also examined.

OEAS 515. Waves and Tides. 3 Credits.
Causes, nature, measurement and analysis of water waves and tides. Mathematical and graphical application to wave and tide problems. Prerequisites: C or better in MATH 212 and PHYS 232N or permission of the instructor.

OEAS 516. Electronics and Oceanographic Instrumentation. 3 Credits.
The course will consist of brief lectures and hands-on laboratory exercises, in which students will learn to build, use, and debug electronic devices relevant to ocean and earth science applications. Topics covered will include circuit theory, power supplies and budgets, transducers and amplifiers, computerized data acquisition, instrument control, signal conditioning and resolution.

OEAS 518. Limnology: Biogeochemistry of Lakes. 3 Credits.
Chemical cycling in lakes and reservoirs, and interactions with biological and physical processes; quantitative modeling of lake geochemistry.

OEAS 519. Spatial Analysis of Coastal Environments. 3 Credits.
The course integrates remotely sensed and field techniques for scientific investigation and practical management of coastal environmental systems. Spatial modeling of coastal processes and management tools using geographic information system (GIS). Prerequisite: GEOG 504.

OEAS 520. Hydrogeology. 3 Credits.
Topics covered will include the occurrence and movement of surface and subsurface water, the nature and distribution of permeable rocks and strata, field techniques used in ground-water studies, and the flow of ground-water to wells.

OEAS 526. Concepts in Oceanography for Teachers. 3 Credits.
This web-based course will provide a practical introduction to oceanography for earth science teachers. It is particularly aimed at current science teachers attempting to become certified in earth science education. Topics will include discussions of geological, biological, physical and chemical oceanography. Not available for credit for OES majors and minors.

OEAS 530. Introduction to Geophysics. 3 Credits.
Introduction to the physics of the earth, including plate tectonics, volcanism, earthquakes and seismology, gravity, the earth’s magnetic field, geophysical remote sensing, and mantle convection.

OEAS 534. Geodynamics. 3 Credits.
A qualitative and quantitative description of physical processes in the Earth and environmental sciences. Topics include stress and strain, plate elasticity and flexure, heat flow, fluid mechanics, material rheology, and groundwater flow. Emphasis will be placed on developing an understanding of Earth dynamics using real-world examples, including numerical exercises. Prerequisites: MATH 211, MATH 212, PHYS 231N, and PHYS 232N or equivalents.

OEAS 540. Biological Oceanography. 4 Credits.
Marine organisms and their relationship to physical and chemical processes in the ocean. Laboratory study of local marine organisms, marine ecosystem and sampling techniques. Includes identification, data analysis and field trips.

OEAS 551. Data Collection and Analysis in Oceanography. 4 Credits.
This course introduces students to the basic oceanographic instruments used to obtain and analyze information by investigating different locations in the Chesapeake Bay. Data obtained with these instruments will be processed and analyzed using the data analysis techniques discussed in class. The data will then be used to answer a particular question related to the temporal and spatial variability in a natural system. Prerequisites: College level statistics (at least one semester).

OEAS 553. Marine Molecular Ecology. 4 Credits.
This course will explore the ecology of marine organisms using molecular techniques and data. Molecular ecology covers a wide variety of sub-disciplines, including genetics, physiology, ecology, and evolution. The course will explore basic theory in population genetics, ecology, and evolution and cover nucleic acid techniques and their applications.

OEAS 566. Introduction to Mitigation and Adaptation. 3 Credits.
Students will be introduced to the science underpinning mitigation of human-induced changes in the Earth system, including but not limited to climate change and sea level rise, and adaptation to the impacts of these changes. The course will cover the environmental hazards and the opportunities and limitations for conservation, mitigation and adaptation. Cross listed with BIOL 566.

OEAS 567. Sustainability Leadership. 3 Credits.
In this class, students will discover what makes a leader for sustainability. They will consider a range of global and local crises from a leadership point of view in the context of sustainability science, which addresses the development of communities in a rapidly changing social, economic, and environmental system-of-systems environment. The course will be based on taking a problem-motivated and solution-focused approach to the challenges considered. The course includes a service learning project focusing on a leadership experience in solving a real-world environmental problem. Prerequisite: BIOL 566 or OEAS 566.

OEAS 595. Special Topics. 1-4 Credits.
Lectures, field and laboratory studies. An investigation of a selected problem in physical, geological, chemical, or biological oceanography. Prerequisites: permission of the instructor.

OEAS 603. Geobiology. 3 Credits.
Geobiology and the associated field of biosemdimentology reflect the interdisciplinary approach to environmental problems, questions related to Earth history, and the exploration of extraterrestrial worlds. The course elaborates our understanding of geobiology and biosementology by conducting a study on benthic cyanobacteria and their influences on sedimentary processes in marine environments. Study area is Fisherman’s Island, located close to Norfolk, VA. The course includes aspects of astrobiology (the “sister of geobiology”), and discusses the evolution of life on Earth.
Oeas 604. Introduction to Physical Oceanography. 3 Credits.
Introduction to descriptive and dynamical physical oceanography. Properties of sea water; distribution of temperature, salinity and density; water, salt, and heat budgets; techniques for describing the ocean; circulation and water masses of the world’s oceans and coastal waters.

Oeas 605. Introduction to Ocean Modeling and Prediction. 3 Credits.
Instructor approval required. Introduction to concepts and theories of numerical ocean models and their applications in physical oceanography, computational fluid dynamics, environmental problems and ocean forecast systems. Prerequisite: Oeas 505 or Oeas 604.

Oeas 606. Experimental Procedures in Physical Oceanography. 3 Credits.
Provides basic knowledge for conducting field experiments in physical oceanography. Fundamentals of experimental design and sampling theory. Standard methods of data reduction, analysis, and reporting.

Oeas 607. Introduction to Python for Data Analysis. 1 Credit.
The goal of this class is to introduce students to the Python programming language, and to equip them with basic coding, data management and version control skills that will allow them to get more research done in less time and with less pain (computationally-speaking).

Oeas 610. Advanced Chemical Oceanography. 3 Credits.
Chemical properties of seawater; chemical composition of the ocean including major and trace elements, dissolved gases, micronutrient elements, and organic compounds; processes controlling this composition.

Oeas 611. Chemical Oceanography Laboratory. 3 Credits.
Basic analytical chemistry of seawater; field work in chemical oceanography.

Oeas 612. Marine Geochemistry. 3 Credits.
Processes governing the chemical composition of the ocean. Riverine input; air-sea exchange; sediment-bottom water exchange; hydrothermal input; internal cycling by physical processes; numerical modeling in chemical oceanography. Prerequisite: Oeas 610.

Oeas 613. Geochemistry of Marine Sediments. 3 Credits.
An introduction to the geochemistry of marine sediments, with an emphasis on nutrient (C,N,P,S) and trace element cycling in marine sediments. Prerequisites: Oeas 610 and Oeas 612.

Oeas 614. Estuarine and Coastal Biogeochemical Cycles. 3 Credits.
Chemical dynamics within water and sediments of estuaries, salt marshes, and the continental shelf; river-sea, air-sea, and sediment-water interactions; modeling techniques. Prerequisite: Oeas 610.

Oeas 616. Advanced Chemical Oceanography Laboratory. 3 Credits.
Analysis of trace constituents in marine waters, sediments, and sediment porewaters; sampling techniques; field experience. Prerequisite: Oeas 611.

Oeas 620. Advanced Geological Sciences. 3 Credits.
Survey of marine and terrestrial geology and geophysics; plate tectonics and basin formation; marine sediments and sediment dynamics; marine depositional environments and depositional systems; marine stratigraphy dynamics and the formation of marine basins.

Oeas 622. Wetland Hydrology. 3 Credits.
Hydrologic criteria used to delineate wetlands. Techniques used to calculate components of water budgets for non-tidal wetlands. Many lab exercises will require extensive field work in wetlands.

Oeas 625. Marine Sedimentary Environments. 3 Credits.
Attributes of marine sediments; main sedimentary facies zones in marine and coastal environments (deep sea, shelf, tidal flats, lagoons, barrier islands); modern depositional systems versus ancient depositional systems; reefs (brachiopoda, corals, sponges, foraminifers, etc); traces and trace fossils. Prerequisites: Oeas 620.

Oeas 630. Dynamical Oceanography I. 3 Credits.
Dynamics of rotating, stratified fluids, geostrophic adjustment, potential vorticity, Ekman layers, gravity waves, and large scale ocean circulation. Prerequisites: Oeas 604 and Math 691.

Oeas 640. Advanced Biological Oceanography. 4 Credits.
Marine organisms and their interactions with the physical and chemical environments of the sea; primary production, population ecology, nutrition, reproduction, and marine biogeography; related laboratory exercises.

Oeas 651. Introduction to Physics of Estuaries. 3 Credits.
This course considers the physical oceanography of estuaries. In particular, it explores how circulation and mixing in estuaries are influenced by atmospheric forcing, tidal forcing, coastal influences and bathymetric variability. Topics to be treated include classification of estuaries, typical steady dynamical balances, transport of salt and other quantities, mixing, and time-space scales of variability. Prerequisite: Oeas 604.

Oeas 658. Participatory and Agent-Based Modeling, Simulation, and Visualization. 3 Credits.
Many societal challenges are “wicked problems,” i.e., social or cultural problems that are difficult or impossible to solve. The class will introduce the students to the theory of wicked problems, engage them in transdisciplinary approaches to address such problems using collaborative strategies such as participatory modeling combined with conceptual and agent-based models. Scenario-based simulations and visualizations will be used to explore possible futures and to create foresight related to wicked problems. Prerequisites: Oeas 566/Biol 566 or permission of the instructors.

Oeas 667. Cooperative Education. 1-3 Credits.
Available for pass/fail grading only. May be repeated for credit. Student participation for credit based on the academic relevance of the work experience, criteria, and evaluative procedures as formally determined by the department and Career Development Services prior to the semester in which the work experience is to take place. Prerequisites: approval by the department and Career Development Services in accordance with the policy for granting credit for Cooperative Education programs.

Oeas 669. Internship in Oceanography. 1-3 Credits.
1-3 credits. Prerequisite: permission of the department.

Oeas 690. Topics in Marine Environmental Policy. 3 Credits.
This course will give students a working understanding of how science policy decisions are made by governments and how science and technology impact public policy. This course seeks to integrate current policy/legislative initiatives with the underlying scientific issues in order to raise the student’s appreciation for and understanding of the various influences that affect the decision-making process. In particular, the course will look at how science influences policy and assess the “state of the science” relative to the issues at stake.

Oeas 691. Seminar. 1 Credit.
Techniques for presenting scientific data at professional meetings and seminars. Practical experience and feedback.

Oeas 695. Special Topics in Oceanography. 1-3 Credits.
An advanced investigation in a selected problem in physical, geological, chemical, or biological oceanography under the direction of the faculty of the Department of Ocean, Earth and Atmospheric Sciences.

Oeas 696. Selected Topics. 1-3 Credits.
An advanced investigation in a selected problem in physical, geological, chemical, or biological oceanography under the direction of the faculty of the Department of Ocean, Earth and Atmospheric Sciences. Prerequisite: permission of the instructor.

Oeas 698. Research. 1-9 Credits.
Any semester; hours to be arranged; variable credit. 1-9 credits per semester. M.S.-level research.

Oeas 699. Thesis. 1-9 Credits.
Any semester; hours to be arranged; variable credit. 1-9 credits per semester. M.S.-level work primarily devoted to the writing of the thesis.

Oeas 704. Time Series in Oceanography. 3 Credits.
A study of the basic techniques used to model and analyze time series of oceanographic data. These include temporal spatial and frequency/wave number domain techniques. Prerequisite: calculus.
OEAS 708. Simulation Techniques for Ocean Circulation. 3 Credits.
Emphasis is on the construction of working ocean models, both vorticity-
stream function and primitive equation models analyzed, mostly finite
difference techniques, implicit and explicit schemes, staggered grids,
discussion of ocean general circulation models. Prerequisites: OEAS 730,
and knowledge of a computer program language (FORTRAN preferred).

OEAS 711. Regional Oceanography. 3 Credits.
The regional oceanography of the major ocean basins, marginal seas,
and coastal oceans. Seasonal and interannual variability. Heat and salt cycles.
Prerequisite: OEAS 604.

OEAS 730. Dynamical Oceanography II. 3 Credits.
Dynamics of rotating stratified fluids. Inertial waves, equatorial dynamics,
coastal dynamics, dynamic instability.

OEAS 732. Advanced Geochemistry of Marine Sediments. 3 Credits.
Advanced topics in the geochemistry of marine sediments, with an emphasis
on mathematical modeling of sedimentary geochemical processes.

OEAS 733. Marine Microbiology. 3 Credits.
The course covers the distribution, abundance, and biogeochemical activities
of microorganisms in the oceans, with emphasis on prokaryotic microbes
and viruses. Symbioses with higher organisms, and applied aspects of
marine microbiology, including biofouling and corrosion, invasive species,
and marine biotechnology are also addressed.

OEAS 735. Paleoclimateology. 3 Credits.
This course focuses on the causes (forcings) of climate change; natural
response time of the climate system; interactions and feedbacks; and the
geologic record in climate change.

OEAS 741. Fisheries Population Dynamics. 4 Credits.
An introduction to the major questions in the management of marine
fisheries: abundance, estimation, distribution, recruitment and optimum
yield. Topics are presented within the context of fisheries management,
marine productivity and population ecology, all of which shape the direction
of the primary literature.

OEAS 743. Applied Methods of Fisheries. 4 Credits.
Practice, principles and theory of applied methods in fisheries. Sampling
and data collection tools, practice, and theory. Principles and theory of age
determination, estimation of abundance, reproductive biology, marking and
tagging, and mark-recapture. Special topics as necessary. Prerequisites:
OEAS 744 and OEAS 844.

OEAS 744. Fisheries Management. 3 Credits.
Quantitative methods for the description and management of fisheries.
Analytical and empirical forecasting models used to study case histories of
managed fish stocks. Case studies of poorly and well managed stocks.

3 Credits.
Topics include the evolution of reproductive strategies, maturation, behavior,
larval ecology, and recruitment.

OEAS 755. Mathematical Modeling of Marine Ecosystems. 3 Credits.
This course is focused on the theory and techniques of mathematical model
development for marine ecosystems. The course is designed to provide an
understanding of how to parameterize interaction among components of
marine food webs and interaction of food web components with physical
environments.

OEAS 764. Coastal Sedimentology. 3 Credits.
Sedimentary processes in different coastal zones will be described:
carbonate, evaporitic, and clastic depositional systems. We will conduct a
small research project along the coast of Virginia. Field trip required.

OEAS 765. Marine Biogeochemistry. 3 Credits.
This class will focus on biologically mediated elemental cycling in aquatic
systems. Assimilatory and dissimilatory biological processes involving
auto- and heterotrophic organisms frequently mediate elemental cycling of
these elements. Inorganic compounds and dissolved and particulate organic
material will be discussed in terms of their biological reactivity and turnover
times in aquatic systems and their contribution to elemental cycling on a
variety of temporal and spatial scales. Also included is the issue of how
community structure and function alter biogeochemical cycles.

OEAS 770. Aquatic Photosynthesis. 4 Credits.
This course examines the physics, chemistry, biology and ecology of
photosynthesis by aquatic organisms. Topics include light harvesting,
energy transfer, carbon metabolism and biosynthesis and their ecological
consequences.

OEAS 772. Aquatic Optics. 4 Credits.
The course covers the physics of light transmission through the aquatic
medium as affected by scattering and absorption, the optical properties of
seawater, suspended particles of living cells, underwater vision and ocean
color.

OEAS 795. Advanced Topics in Oceanography. 1-4 Credits.
An advanced investigation of a selected problem in physical, geological,
chemical, or biological oceanography under the direction of the faculty of
the Department of Ocean, Earth and Atmospheric Sciences.

OEAS 800. Survival Skills for Scientists. 1 Credit.
Seminar class each fall and spring that will address a series of topics to
improve student success as scientists. Pass/fail grading.

OEAS 804. Time Series in Oceanography. 3 Credits.
A study of the basic techniques used to model and analyze time series of
oceanographic data. These include temporal spatial and frequency/wave
number domain techniques. Prerequisite: calculus.

OEAS 808. Simulation Techniques for Ocean Circulation. 3 Credits.
Emphasis is on the construction of working ocean models, both vorticity-
stream function and primitive equation models analyzed, mostly finite
difference techniques, implicit and explicit schemes, staggered grids,
discussion of ocean general circulation models. Prerequisites: OEAS 730,
and knowledge of a computer program language (FORTRAN preferred).

OEAS 811. Regional Oceanography. 3 Credits.
The regional oceanography of the major ocean basins, marginal seas,
and coastal oceans. Seasonal and interannual variability. Heat and salt cycles.
Prerequisite: OEAS 604.

OEAS 830. Dynamical Oceanography II. 3 Credits.
Dynamics of rotating stratified fluids. Inertial waves, equatorial dynamics,
coastal dynamics, dynamic instability.

OEAS 832. Advanced Geochemistry of Marine Sediments. 3 Credits.
Advanced topics in the geochemistry of marine sediments, with an emphasis
on mathematical modeling of sedimentary geochemical processes.

OEAS 833. Marine Microbiology. 3 Credits.
The course covers the distribution, abundance, and biogeochemical activities
of microorganisms in the oceans, with emphasis on prokaryotic microbes
and viruses. Symbioses with higher organisms, and applied aspects of
marine microbiology, including biofouling and corrosion, invasive species,
and marine biotechnology are also addressed.

OEAS 840. Plankton Dynamics. 3 Credits.
This course emphasizes the ecology of heterotrophic plankton from bacteria
to protists, from metazoan invertebrate plankton to fish larvae. Students
will explore the role of plankton groups and species in the context of
pelagic ecosystems. Planktonic processes are not only relevant for the ocean
ecosystem but also for fisheries, aquaculture, environmental and human
health, and global climate. The course consists of lectures, discussion groups
on selected reading material, and laboratory demonstrations.

OEAS 841. Fisheries Population Dynamics. 4 Credits.
An introduction to the major questions in the management of marine
fisheries: abundance, estimation, distribution, recruitment and optimum
yield. Topics are presented within the context of fisheries management,
marine productivity and population ecology, all of which shape the direction
of the primary literature.

OEAS 843. Applied Methods of Fisheries. 4 Credits.
Practice, principles and theory of applied methods in fisheries. Sampling
and data collection tools, practice, and theory. Principles and theory of age
determination, estimation of abundance, reproductive biology, marking and
tagging, and mark-recapture. Special topics as necessary. Prerequisites:
OEAS 744 and OEAS 844.
OEAS 844. Fisheries Management. 3 Credits.
Quantitative methods for the description and management of fisheries. Analytical and empirical forecasting models used to study case histories of managed fish stocks. Case studies of poorly and well managed stocks.

OEAS 847. Reproduction and Larval Ecology of Marine Invertebrates. 3 Credits.
Topics include the evolution of reproductive strategies, maturation, behavior, larval ecology, and recruitment.

OEAS 855. Mathematical Modeling of Marine Ecosystems. 3 Credits.
This course is focused on the theory and techniques of mathematical model development for marine ecosystems. The course is designed to provide an understanding of how to parameterize interaction among components of marine food webs and interaction of food web components with physical environments.

OEAS 864. Coastal Sedimentology. 3 Credits.
Sedimentary processes in different coastal zones will be described: carbonate, evaporitic, and clastic depositional systems. We will conduct a small research project along the coast of Virginia. Field trip required.

OEAS 865. Marine Biogeochemistry. 3 Credits.
This class will focus on biologically mediated elemental cycling in aquatic systems. Assimilatory and dissimilatory biological processes involving auto- and heterotrophic organisms frequently mediate elemental cycling of these elements. Inorganic compounds and dissolved and particulate organic material will be discussed in terms of their biological reactivity and turnover times in aquatic systems and their contribution to elemental cycling on a variety of temporal and spatial scales. Also included is the issue of how community structure and function alter biogeochemical cycles.

OEAS 870. Aquatic Photosynthesis. 4 Credits.
This course examines the physics, chemistry, biology and ecology of photosynthesis by aquatic organisms. Topics include light harvesting, energy transfer, carbon metabolism and biosynthesis and their ecological consequences.

OEAS 872. Aquatic Optics. 4 Credits.
The course covers the physics of light transmission through the aquatic medium as affected by scattering and absorption, the optical properties of seawater, suspended particles of living cells, underwater vision and ocean color.

OEAS 895. Advanced Topics in Oceanography. 1-4 Credits.
An advanced investigation of a selected problem in physical, geological, chemical, or biological oceanography under the direction of the faculty of the Department of Ocean and Earth Sciences.

OEAS 898. Doctoral Research. 1-9 Credits.
Any semester; hours to be arranged; variable credit, 1-9 credits per semester. Ph.D.-level research.

OEAS 899. Dissertation. 1-9 Credits.
Any semester; hours to be arranged; variable credit, 1-9 credits per semester. Ph.D.-level work primarily devoted to the writing of the dissertation.