Ocean and Earth Sciences

Web Site: http://www.odu.edu/oeas (http://www.odu.edu/oeas/)

Fred C. Dobbs, Chair
David J. Burdige, Chief Departmental Advisor

The Department of Ocean and Earth Sciences* offers an undergraduate major in Ocean and Earth Science. Undergraduate majors select one of seven concentrations (biological oceanography, chemical oceanography, environmental sciences, physical oceanography, geology, marine science technology, Earth science education) that lead to the Bachelor of Science in Ocean and Earth Science. A minor in Ocean and Earth Science is also offered. Two graduate programs are offered: the Master of Science in Ocean and Earth Sciences and the Doctor of Philosophy in Oceanography.

The Master of Science degree in Ocean and Earth Sciences has both thesis and non-thesis options. Areas of emphasis in oceanography are biological oceanography, chemical oceanography, geological oceanography, and physical oceanography. Interdisciplinary studies are encouraged. The curriculum is designed to prepare graduates for professional practice in their area of interest.

The department receives considerable support from the Commonwealth and local philanthropic sources, as well as from private industry and area citizens. 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 to carry out these activities. Charter members of the consortium are Old Dominion University, the University of Virginia, Virginia Polytechnic Institute and State University, and the College of William and Mary. The Samuel L. and Fay M. Slover endowment to Old Dominion University in 1986 has significantly accelerated the program of marine studies. In 1991, a Center for Coastal Physical Oceanography (CCPO) was established at Old Dominion University by the Commonwealth of Virginia. The center is a Designated Center for Excellence.

The Department of Ocean and Earth Sciences is housed in two buildings. The Oceanography/Physical Sciences Building contains state-of-the-art teaching laboratories, computer facilities, and research laboratories for biological, chemical and geological oceanography. The Center for Coastal Physical Oceanography is located in the Research I building and houses all of the department's physical oceanography laboratories. The department maintains a 55-foot research vessel, the R/V Fay Slover, primarily for estuarine and coastal studies. In addition to the Slover, the department has a number of small boats, suitable for near shore investigations.

*Department name change pending approval of the State Council of Higher Education for Virginia.

Bachelor of Science—Ocean and Earth Science Major

David J. Burdige, Advisor

Students in the Ocean and Earth Science program focus on global systems that control environmental conditions on the planet. They also learn to develop solutions to complex environmental problems by working in interdisciplinary teams. All majors in the department complete courses in the basic sciences and mathematics, core courses in Earth systems science, and (in the three oceanography concentrations and the geology concentration) a capstone field research experience. In addition, students complete a suite of specialty courses according to one of the following concentrations. A minimum grade of C or higher in all major and prerequisite courses is required for graduation.

Biological, Chemical, and Physical Oceanography Concentrations

The three oceanography concentrations are designed for students considering graduate work or employment in the pure and applied fields of oceanography. If students select the biological oceanography concentration, they are strongly encouraged to minor in biology and select 12 credits from 300/400 level biology courses. If students select the chemical oceanography concentration, they are strongly encouraged to minor in chemistry and select the following courses: CHEM 211-CHEM 213, CHEM 212-CHEM 214, CHEM 321 and CHEM 322. If students select the physical oceanography concentration, they are strongly encouraged to minor in applied mathematics and select the following courses: MATH 312, MATH 316, MATH 317 and MATH 401.

Environmental Sciences Concentration

The environmental sciences concentration is designed for students broadly interested in earth and ocean sciences. Students in this concentration gain a solid background in basic sciences (e.g., chemistry, physics, math, and biology) while also taking courses in geology, oceanography, and atmospheric sciences. The concentration is also designed to allow students the freedom to focus their upper-level coursework in a disciplinary field in ocean and earth sciences they find most compelling. Student in this concentration will be prepared for a wide range of future scientific pursuits (including graduate studies in appropriate fields), as well as work (or graduate studies) that applies their skills to policy development and interpretation. Specific employment opportunities include work in local, state, and federal government agencies, environmental consulting firms, and non-governmental organizations (NGOs).

Geology Concentration

The geology concentration is designed for students with a wide range of professional goals in the sciences, engineering, business, and the arts. Students considering graduate work or employment in pure and applied fields of geology, including environmental geology, geological oceanography, hydrogeology, marine geology, geobiology, geophysics, and geochemistry, should build their backgrounds to support certification as a professional geologist (see later information). Students with a strong interest in geological applications of geographic information systems (GIS) and remote sensing tools should consider the geology concentration with a minor in geography; the certificate program in spatial analysis of coastal environments (see later description) also emphasizes this area of study.

Marine Science Technology Concentration

The marine science technology concentration is designed for students interested in the more practical and technical side of oceanography. Students in this concentration will gain practical skills in data acquisition and processing, field operations, and instrument design, assembly, operation, and maintenance. Whereas other concentrations in ocean and earth science emphasize more theoretical aspects of these fields, this concentration focuses on hands-on skills. Upon graduation, students in this concentration will be able to work closely with scientists, researchers, and engineers on wide ranging projects in the environmental science and technology fields. For example, these include potential job opportunities associated with Virginia's offshore wind resource development, which involve collecting and analyzing meteorological, oceanographic and environmental data, upgrading port and logistics facilities, and ensuring this development is compatible with other ocean uses.

Earth Science Education Concentration

The earth science education concentration is designed for students preparing to teach Earth science in secondary schools. This program meets the requirements for teacher licensure in Virginia as established by the Virginia Board of Education licensure regulations.

Requirements for all Concentration Areas

Lower-Division General Education

<table>
<thead>
<tr>
<th>Composition (grade of C or better required in both courses)</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGL 110C English Composition (C or better required)</td>
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</tr>
<tr>
<td>ENGL 231C Introduction to Technical Writing (C or better required)</td>
<td></td>
</tr>
</tbody>
</table>

Oral Communication
Met in the major by

OEAS 441 or OEAS 444 Ocean and Earth Sciences Field Study I
or OEAS 444 Communicating Ocean Science to Informal Audiences

Students in the Oceanography and Geology concentrations take OEAS 441. Students in Environmental Sciences, Marine Science Technology, and Earth Science Education concentrations take OEAS 444.

Mathematics

MATH 211 Calculus I
or MATH 205 Calculus for Life Sciences

MATH 205 only accepted in the Environmental Sciences and Marine Science Technology concentrations

Language and Culture

0-6

Information Literacy and Research (met in the major by OEAS 130G)

Human Creativity 3

Interpreting the Past 3

Literature 3

Philosophy and Ethics 3

The Nature of Science

CHEM 121N & CHEM 122N Foundations of Chemistry I Lecture
and Foundations of Chemistry I Laboratory

CHEM 123N & CHEM 124N Foundations of Chemistry II Lecture
and Foundations of Chemistry II Laboratory

Impact of Technology (met in the major by OEAS 220T for Earth Science Education, Environmental Sciences and Marine Science Technology concentrations) 0-3

Human Behavior 3

Total Hours 32-42

Students must select one of the following options:

Course Requirements – Biological Oceanography Concentration

BIOL 121N General Biology I 4
& BIOL 122N and General Biology I Lab

BIOL 123N General Biology II 4
& BIOL 124N and General Biology II Lab

MATH 212 Calculus II 4

OEAS 111N Physical Geology 4

OEAS 130G Research Skills and Information Literacy for the Natural Sciences 3

OEAS 306 Oceanography 3

OEAS 307 Oceanography Laboratory 1

PHYS 231N University Physics I 8
& PHYS 232N and University Physics II

OEAS 310 Global Earth Systems 4

STAT 310 Introductory Data Analysis 3

OEAS 406 Matlab 1

OEAS 440 Biological Oceanography 4

BIOL 292 Evolution 3

BIOL 415W or OEAS 451W Marine Ecology 4-5
Data Collection and Analysis in Oceanography

CHEM 211 Organic Chemistry I Lecture 3

CHEM 212 Organic Chemistry I Laboratory 2

CHEM 213 Organic Chemistry II Lecture 3

CHEM 441 Biochemistry Lecture 3

OEAS 441 or OEAS 442W Ocean and Earth Sciences Field Study I and Ocean and Earth Sciences Field Study II (satisfies oral and upper-division written communication requirement) 6

Select two of the following electives:

OEAS 403W Aquatic Pollution 6

OEAS 405 Physical Oceanography

OEAS 410 Chemical Oceanography

OEAS 412 Global Environmental Change

OEAS 413 Environmental Geochemistry

OEAS 416 Electronics and Oceanographic Instrumentation

OEAS 418 Limnology: Biogeochemistry of Lakes

OEAS 420 Hydrogeology

OEAS 448 Population Ecology

OEAS 452 Microbial Ecology of the Oceans

OEAS 451W Data Collection and Analysis in Oceanography (if not taken in lieu of BIOL 415W)

OEAS 453W Marine Molecular Ecology

OEAS 466W Introduction to Mitigation and Adaptation Studies

Total Hours 73-74

Four-Year Plan - Biological Oceanography Concentration - BS (http://catalog.odu.edu/undergraduate/collegeofsciences/oceanearthatmosphericsciences/oeas-bioloceanography-bs-fouryearplan/)

This is a suggested curriculum plan to complete this degree program in four years. Please consult information in this Catalog, Degree Works, and your academic advisor for more specific information on course requirements for this degree.

Course Requirements – Chemical Oceanography Concentration

BIOL 121N General Biology I 4
& BIOL 122N and General Biology I Lab

BIOL 123N General Biology II 4
& BIOL 124N and General Biology II Lab

OEAS 111N Physical Geology 4

OEAS 130G Research Skills and Information Literacy for the Natural Sciences 3

CHEM 211 Organic Chemistry I Lecture 6
& CHEM 213 and Organic Chemistry II Lecture

MATH 212 Calculus II 4

OEAS 306 Oceanography 3

OEAS 307 Oceanography Laboratory 1

PHYS 231N University Physics I 8
& PHYS 232N and University Physics II

OEAS 310 Global Earth Systems 4

STAT 310 Introductory Data Analysis 3

OEAS 406 Matlab 1

OEAS 410 Chemical Oceanography 3

OEAS 441 or OEAS 442W Ocean and Earth Sciences Field Study I and Ocean and Earth Sciences Field Study II (satisfies oral and upper-division written communication requirement).

Select one of the following:

CHEM 322 Analytical Chemistry Laboratory 2-4

CHEM 332W Experimental Physical Chemistry I

CHEM 334W Experimental Physical Chemistry II

CHEM 352 Inorganic Chemistry Laboratory

CHEM 422 Instrumental Analysis Laboratory

Ocean and Earth Sciences 2
Four-Year Plan - Chemical Oceanography Concentration - BS (http://catalog.odu.edu/undergraduate/collegeofsciences/oceanearthatmosphericsciences/oceanschemoceanography-bs-fouryearplan/)

This is a suggested curriculum plan to complete this degree program in four years. Please consult information in this Catalog, Degree Works, and your academic advisor for more specific information on course requirements for this degree.

Course Requirements – Physical Oceanography Concentration

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>BIOL 121N</td>
<td>General Biology I</td>
<td>4</td>
</tr>
<tr>
<td>&amp; BIOL 122N</td>
<td>General Biology I Lab</td>
<td></td>
</tr>
<tr>
<td>BIOL 123N</td>
<td>General Biology II</td>
<td>4</td>
</tr>
<tr>
<td>&amp; BIOL 124N</td>
<td>General Biology II Lab</td>
<td></td>
</tr>
<tr>
<td>OEAS 111N</td>
<td>Physical Geology</td>
<td>4</td>
</tr>
<tr>
<td>OEAS 130G</td>
<td>Research Skills and Information Literacy</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>for the Natural Sciences</td>
<td></td>
</tr>
<tr>
<td>MATH 212</td>
<td>Calculus II</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 231N</td>
<td>University Physics I</td>
<td>8</td>
</tr>
<tr>
<td>&amp; PHYS 232N</td>
<td>University Physics II</td>
<td></td>
</tr>
<tr>
<td>OEAS 306</td>
<td>Oceanography</td>
<td>3</td>
</tr>
<tr>
<td>OEAS 307</td>
<td>Oceanography Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>STAT 310</td>
<td>Introductory Data Analysis</td>
<td>3</td>
</tr>
<tr>
<td>OEAS 310</td>
<td>Global Earth Systems</td>
<td>4</td>
</tr>
<tr>
<td>OEAS 405</td>
<td>Physical Oceanography</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Hours: 71-74

Four-Year Plan - Physical Oceanography Concentration - BS (http://catalog.odu.edu/undergraduate/collegeofsciences/oceanearthatmosphericsciences/oceansphyscialoceanography-bs-fouryearplan/)

This is a suggested curriculum plan to complete this degree program in four years. Please consult information in this Catalog, Degree Works, and your academic advisor for more specific information on course requirements for this degree.

Course Requirements - Environmental Sciences Concentration

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>OEAS 111N</td>
<td>Physical Geology</td>
<td>4</td>
</tr>
<tr>
<td>OEAS 130G</td>
<td>Research Skills and Information Literacy</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>for the Natural Sciences</td>
<td></td>
</tr>
<tr>
<td>BIOL 121N</td>
<td>General Biology I</td>
<td>4</td>
</tr>
<tr>
<td>&amp; BIOL 122N</td>
<td>General Biology I Lab</td>
<td></td>
</tr>
<tr>
<td>BIOL 123N</td>
<td>General Biology II</td>
<td>4</td>
</tr>
<tr>
<td>&amp; BIOL 124N</td>
<td>General Biology II Lab</td>
<td></td>
</tr>
<tr>
<td>PHYS 111N</td>
<td>Introductory General Physics</td>
<td>4</td>
</tr>
<tr>
<td>or PHYS 231N</td>
<td>University Physics I</td>
<td></td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
<td>Credits</td>
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</tr>
<tr>
<td>BIOL 121N</td>
<td>General Biology I</td>
<td>4</td>
</tr>
<tr>
<td>&amp; BIOL 122N</td>
<td>General Biology I Lab</td>
<td></td>
</tr>
<tr>
<td>BIOL 123N</td>
<td>General Biology II</td>
<td>4</td>
</tr>
<tr>
<td>&amp; BIOL 124N</td>
<td>General Biology II Lab</td>
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<tr>
<td>MATH 212</td>
<td>Calculus II</td>
<td>4</td>
</tr>
<tr>
<td>OEAS 130G</td>
<td>Research Skills and Information Literacy for the Natural Sciences</td>
<td>3</td>
</tr>
<tr>
<td>&amp; OEAS 111N</td>
<td>Physical Geology</td>
<td>8</td>
</tr>
<tr>
<td>&amp; OEAS 112N</td>
<td>Historical Geology</td>
<td>8</td>
</tr>
<tr>
<td>PHYS 231N</td>
<td>University Physics I</td>
<td>8</td>
</tr>
<tr>
<td>&amp; PHYS 232N</td>
<td>University Physics II</td>
<td></td>
</tr>
<tr>
<td>OEAS 306</td>
<td>Oceanography</td>
<td>3</td>
</tr>
<tr>
<td>OEAS 307</td>
<td>Oceanography Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>OEAS 310</td>
<td>Global Earth Systems</td>
<td>4</td>
</tr>
<tr>
<td>OEAS 406</td>
<td>Matlab</td>
<td>1</td>
</tr>
<tr>
<td>OEAS 444</td>
<td>Communicating Ocean Science to Informal Audiences (meets Oral Communication)</td>
<td>3</td>
</tr>
<tr>
<td>OEAS 451W</td>
<td>Data Collection and Analysis in Oceanography</td>
<td>3-4</td>
</tr>
<tr>
<td>or GEOG 402</td>
<td>Geographic Information Systems</td>
<td></td>
</tr>
</tbody>
</table>

**Upper-Division Electives (all 300-400 Level OEAS courses) * 19**

Select courses from the list below for a total of 19 credits hours

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>OEAS 250N</td>
<td>Natural Hazards and Disasters (L)</td>
<td></td>
</tr>
<tr>
<td>OEAS 303</td>
<td>Paleontology (L)</td>
<td></td>
</tr>
<tr>
<td>OEAS 315</td>
<td>Minerals and Rocks (L)</td>
<td></td>
</tr>
<tr>
<td>OEAS 320</td>
<td>Sedimentology and Stratigraphy (L; can be used as an elective only if not taken as required course above)</td>
<td></td>
</tr>
<tr>
<td>OEAS 344W</td>
<td>Geomorphology</td>
<td></td>
</tr>
<tr>
<td>OEAS 403W</td>
<td>Aquatic Pollution</td>
<td></td>
</tr>
<tr>
<td>OEAS 405</td>
<td>Physical Oceanography</td>
<td></td>
</tr>
<tr>
<td>OEAS 410</td>
<td>Chemical Oceanography</td>
<td></td>
</tr>
<tr>
<td>OEAS 411</td>
<td>Structural Geology</td>
<td></td>
</tr>
<tr>
<td>OEAS 412</td>
<td>Global Environmental Change</td>
<td></td>
</tr>
<tr>
<td>OEAS 413</td>
<td>Environmental Geochemistry</td>
<td></td>
</tr>
<tr>
<td>OEAS 415</td>
<td>Waves and Tides</td>
<td></td>
</tr>
<tr>
<td>OEAS 416</td>
<td>Electronics and Oceanographic Instrumentation</td>
<td></td>
</tr>
<tr>
<td>OEAS 418</td>
<td>Limnology: Biogeochemistry of Lakes</td>
<td></td>
</tr>
<tr>
<td>OEAS 419</td>
<td>Spatial Analysis of Coastal Environments</td>
<td></td>
</tr>
<tr>
<td>OEAS 420</td>
<td>Hydrogeology (L)</td>
<td></td>
</tr>
<tr>
<td>OEAS 430</td>
<td>Introduction to Geophysics</td>
<td></td>
</tr>
<tr>
<td>OEAS 434</td>
<td>Geodynamics</td>
<td></td>
</tr>
<tr>
<td>OEAS 440</td>
<td>Biological Oceanography (L)</td>
<td></td>
</tr>
<tr>
<td>OEAS 448</td>
<td>Population Ecology</td>
<td></td>
</tr>
<tr>
<td>OEAS 452</td>
<td>Microbial Ecology of the Oceans (L)</td>
<td></td>
</tr>
<tr>
<td>OEAS 453W</td>
<td>Marine Molecular Ecology (L)</td>
<td></td>
</tr>
<tr>
<td>OEAS 466W</td>
<td>Introduction to Mitigation and Adaptation Studies</td>
<td></td>
</tr>
<tr>
<td>OEAS 467</td>
<td>Sustainability Leadership</td>
<td></td>
</tr>
<tr>
<td>OEAS 468W</td>
<td>Research Methods in Math and Sciences</td>
<td></td>
</tr>
<tr>
<td>OEAS 490</td>
<td>Paleogeography</td>
<td></td>
</tr>
</tbody>
</table>

**Total Hours** 66-67

* For these upper-division courses please pay careful attention to prerequisites that may not necessarily also be required courses in the concentration. A minimum of two courses must have a structured laboratory or field requirement (indicated by L). Up to 4 credits of 200-level courses may be used to satisfy this upper-division requirement. Up to six credit hours of electives from departments outside of Ocean and Earth Sciences on an approved electives list can be used to satisfy this requirement (see the Chief Departmental Advisor for details). At least one writing-intensive "W" course must be taken within the major.
Four-Year Plan - Geology Concentration
- BS (http://catalog.odu.edu/undergraduate/collegeofsciences/oeas-geology-bs-fouryearplan/)

This is a suggested curriculum plan to complete this degree program in four years. Please consult information in this Catalog, Degree Works, and your academic advisor for more specific information on course requirements for this degree.

<table>
<thead>
<tr>
<th>Course Requirements – Marine Science Technology Concentration</th>
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</thead>
<tbody>
<tr>
<td>OEAS 111N</td>
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<tr>
<td>OEAS 130G</td>
</tr>
<tr>
<td>BIOL 121N &amp; BIOL 122N</td>
</tr>
<tr>
<td>BIOL 123N &amp; BIOL 124N</td>
</tr>
<tr>
<td>PHYS 111N or PHYS 231N</td>
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<tr>
<td>OEAS 220T</td>
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<tr>
<td>OEAS 306</td>
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<tr>
<td>OEAS 307</td>
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<tr>
<td>OEAS 310</td>
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<tr>
<td>STAT 310</td>
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<td>OEAS 406</td>
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<td>OEAS 416</td>
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<tr>
<td>OEAS 444</td>
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<tr>
<td>OEAS 451W</td>
</tr>
<tr>
<td>GEOG 402</td>
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<tr>
<td>Upper-Division OEAS Electives*</td>
</tr>
<tr>
<td>OEAS 303</td>
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<tr>
<td>OEAS 315</td>
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<tr>
<td>OEAS 320</td>
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<tr>
<td>OEAS 344W</td>
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<td>OEAS 403W</td>
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<td>OEAS 405</td>
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<td>OEAS 412</td>
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<tr>
<td>OEAS 418</td>
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<td>OEAS 415</td>
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</tbody>
</table>

Four-Year Plan - Marine Science Technology Concentration - BS (http://catalog.odu.edu/undergraduate/collegeofsciences/oeas-marinesciencetech-bs-fouryearplan/)

This is a suggested curriculum plan to complete this degree program in four years. Please consult information in this Catalog, Degree Works, and your academic advisor for more specific information on course requirements for this degree.

Elective Credit
Elective credit may be needed to meet the minimum requirement of 120 credit hours.

Upper-Division General Education
For students in the Earth science education concentration, completion of the professional education courses satisfies this requirement. All other students can satisfy this requirement in one of four ways:

- Option A: Approved Disciplinary Minor (a minimum of 12 hours determined by the department), or second degree or second major.
- Option B: Interdisciplinary Minor (specifically 12 hours, 3 of which may be in the major)
- Option C: International Business and Regional Courses or an approved Certification Program such as teaching licensure
- Option D: Two Upper-Division Courses from outside the College of Sciences and not required by the major (6 hours)

Requirements for Graduation
Requirements for graduation in all options listed above except Earth science education include a minimum cumulative grade point average of 2.00 overall and in the major with a grade of C or better in all major and prerequisite courses, 120 credit hours, which must include both a minimum of 30 credit hours overall and 12 credit hours in upper-level courses in the major program from Old Dominion University, completion of ENGL 110C, ENGL 211C or ENGL 221C or ENGL 231C, and the writing intensive (W) course in the major with a grade of C or better, and completion of Senior Assessment. Requirements for Earth science are noted under course requirements for Earth science education.

Earth Science Education Concentration
Due to changing University requirements, national accreditation standards, and the Virginia Board of Education licensure regulations, the teacher preparation programs in the College of Sciences are under constant revision. Any changes resulting from these factors supersede the program requirements described in this Catalog. Students are encouraged to obtain current program information from their advisors and the Office of Clinical Experiences website at www.odu.edu/oce (http://www.odu.edu/oce/).

Admission
Students must first declare the Ocean and Earth Science major, Earth science education concentration with the chief departmental advisor. All students must apply for and be admitted into the approved earth science teacher preparation program. Students must meet the required criteria for admission...
by passing the Virginia Board of Education prescribed assessments and earn
the minimum required grade point averages (GPA).

Prescribed Virginia Board of Education Assessment for
Admission to an Approved Teacher Education Program

Old Dominion University students seeking admission to an approved teacher
education program must have submitted Praxis Core or approved alternative
test of mathematics, reading, and writing (SAT or ACT).

For the most current information on the prescribed Virginia Board of
Education admission assessment, visit the Office of Clinical Experiences
website, http://www.odu.edu/ceed (http://www.odu.edu/ceed/) and review the
Professional Education Handbook.

Required grade point averages (GPA):

- A cumulative GPA of 2.75 is required.
- A major/content GPA of 2.75 is required - all Ocean, Earth and
  Atmospheric Sciences courses and all other science and mathematics
  content courses must be passed with a grade of C (2.0) or higher.
- A professional education GPA of 2.75 is required – all professional
  education courses must be passed with a grade of C- or higher.

Although students may enroll in a limited number of education courses,
students must be admitted into the approved earth science teacher
preparation program prior to enrolling in any instructional strategies
practicum education course. Students must also meet with an education
advisor in the Office of Clinical Experiences.

Continuance

Students must maintain a cumulative GPA of 2.75, a major/content GPA
of 2.75 and a professional education GPA of 2.75. Ocean, Earth and
Atmospheric Sciences content courses must be passed with a grade of C (2.0)
or higher. Courses in the professional education core must be
completed with a grade of C- or higher for continuance. A professional
education GPA of 2.75 is required for continuance. Students must take and
pass the Virginia Communication and Literacy Assessment (VCLA) and the
Praxis Subject Assessment, Earth and Spaces Sciences content knowledge
(formerly Praxis II) prior to or while enrolled in the instructional strategies
course. All assessments must be passed prior to the start of the Teacher
Candidate Internship Orientation session.

Background Clearance Requirement

Old Dominion University requires a background clearance check of
candidates interested in many of the professional education programs.
Professional education programs have several field experiences that are
required for continuance and graduation from the program. The background
clearance must be successfully completed prior to a field experience
placement. Candidates will be provided a field experience placement
when the background check process is completed with resolution of any
issues. The process to complete the ODU clearance background check is
located at: http://www.odu.edu/success/academic/teacher-education/
placement/background-checks (http://www.odu.edu/success/academic/
teacher-education/placement/background-checks/). The ODU clearance
process includes: an FBI fingerprint, a child protective service/social service
review, and a Virginia State Police sex offender registry review. Candidates
interested in the professional education programs are advised to complete
this clearance process immediately upon entry into the program since the
clearance process takes a minimum of eight weeks to complete.

Virginia Board of Education Prescribed Assessments for
Licensure

- Virginia Communication and Literacy Assessment (VCLA) – a
  passing composite score of 470 is required on this reading and writing
  assessment
- Praxis Subject Assessment, Earth and Spaces Sciences content
  knowledge (test code: 5571) – passing score of 156 required

To review more information on the Virginia Board of Education prescribed
assessments visit the Office of Clinical Experiences website, www.odu.edu/
ceed (http://www.odu.edu/ceed/).

Graduation

Requirements for graduation include completion of ENGL 110C,
ENGL 211C or ENGL 221C or ENGL 231C, and the writing intensive (W)
course in the major with a grade of C or better, completion of the Senior
Assessment, a minimum cumulative 2.75 GPA, in the major area, and in
the professional education core, with no grade less than a C in the major and
C- in the professional education core; successful completion of the
Teacher Candidate Internship and a minimum of 120 credit hours, which
must include both a minimum of 30 credit hours overall and 12 credit hours
in upper-level courses in the major program from Old Dominion University.
Note that a C (2.0) must be earned in all Ocean, Earth and Atmospheric
Sciences courses used to satisfy departmental requirements.

Course Requirements – Earth Science Education
Concentration

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>BIOL 121N</td>
<td>General Biology I</td>
<td>4</td>
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<tr>
<td>&amp; BIOL 122N</td>
<td>and General Biology I Lab</td>
<td></td>
</tr>
<tr>
<td>STAT 310</td>
<td>Introductory Data Analysis</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 111N</td>
<td>Introductory General Physics</td>
<td>8</td>
</tr>
<tr>
<td>&amp; PHYS 112N</td>
<td>Introductory General Physics</td>
<td></td>
</tr>
<tr>
<td>OEAS 111N</td>
<td>Physical Geology</td>
<td>4</td>
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<tr>
<td>OEAS 112N</td>
<td>Historical Geology</td>
<td>4</td>
</tr>
<tr>
<td>OEAS 130G</td>
<td>Research Skills and Information Literacy for</td>
<td>3</td>
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<tr>
<td></td>
<td>the Natural Sciences</td>
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<tr>
<td>OEAS 220T</td>
<td>Introduction to Meteorology</td>
<td>3</td>
</tr>
<tr>
<td>OEAS 303</td>
<td>Paleontology</td>
<td>3</td>
</tr>
<tr>
<td>OEAS 306</td>
<td>Oceanography</td>
<td>3</td>
</tr>
<tr>
<td>OEAS 310</td>
<td>Global Earth Systems</td>
<td>4</td>
</tr>
<tr>
<td>OEAS 315</td>
<td>Minerals and Rocks</td>
<td>4</td>
</tr>
<tr>
<td>OEAS 320</td>
<td>Sedimentology and Stratigraphy</td>
<td>4</td>
</tr>
<tr>
<td>OEAS 344W</td>
<td>Geomorphology</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 408</td>
<td>Astronomy for Teachers</td>
<td>3</td>
</tr>
<tr>
<td>OEAS 441</td>
<td>Ocean and Earth Sciences Field Study I</td>
<td>6</td>
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<tr>
<td>&amp; OEAS 442W</td>
<td>and Ocean and Earth Sciences Field Study</td>
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<td>II (satisfies oral communication and upper-</td>
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<td></td>
<td>division writing intensive requirement)</td>
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<td>or</td>
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<tr>
<td>OEAS 444</td>
<td>Communicating Ocean Science to Informal</td>
<td>2</td>
</tr>
<tr>
<td>&amp; OEAS 468W</td>
<td>Audiences</td>
<td></td>
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<tr>
<td></td>
<td>and Research Methods in Math and Sciences</td>
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<tr>
<td></td>
<td>(an alternative to OEAS 441-OEAS 442W for</td>
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<td>the Earth science education emphasis;</td>
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<td>satisfies oral communication requirement)</td>
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<tr>
<td>Additional electives as needed to meet 120 credit hours; upper-</td>
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<tr>
<td>division OEAS electives recommended</td>
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</tbody>
</table>

Total Hours

61

The Professional Education core courses and
requirements are as follows:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEM 101</td>
<td>Step 1 – Inquiry Approaches to Teaching</td>
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</tr>
<tr>
<td></td>
<td>STEM</td>
<td></td>
</tr>
<tr>
<td>STEM 102</td>
<td>Step 2 - Inquiry Based STEM Lesson Design</td>
<td>1</td>
</tr>
<tr>
<td>STEM 201</td>
<td>Knowing and Learning in STEM Education</td>
<td>3</td>
</tr>
<tr>
<td>STEM 202</td>
<td>Classroom Interactions in STEM Education</td>
<td>3</td>
</tr>
<tr>
<td>STEM 401</td>
<td>Project Based Instruction in STEM Education</td>
<td>3</td>
</tr>
<tr>
<td>STEM 402</td>
<td>Perspectives on STEM</td>
<td>3</td>
</tr>
<tr>
<td>STEM 485</td>
<td>Apprentice Teaching</td>
<td>9</td>
</tr>
</tbody>
</table>
Applicants must have already declared a major and have a minimum GPA of 2.00. Students wishing to pursue a minor in Ocean and Earth Science may elect to emphasize any aspect of biological, chemical, physical, or geological science from course offerings available to Ocean and Earth Science majors, and must complete 12 credit hours of OEAS coursework at the 300 and/or 400 level. The following courses do not satisfy the minor requirements: OEAS 302, OEAS 402, and OEAS 426.

For completion of a minor, a student must have a C or better in each course taken for the minor including prerequisites and a minimum overall cumulative grade point average of 2.00 in all courses specified as a requirement for the minor exclusive of lower-level courses and prerequisite courses. A minimum of six hours in upper-level courses in the minor requirement must be completed through courses offered by Old Dominion University.

Certificate in Spatial Analysis of Coastal Environments (Undergraduate and Graduate)

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 geographic information systems (GIS) applications. Rendered upon completion of the requirements, the certificate is an academic affidavit comprised of courses in geography and ocean and earth science and is administered by the two departments. 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). Students must complete a minimum of six hours in upper-level courses required for the certificate through courses offered by Old Dominion University.

The certificate is available to postgraduate professionals who meet the requirements. Students with comparable professional experience may be able to show competence in selected courses through examination.

Students seeking undergraduate certification complete the 400-level courses, and those seeking graduate certification complete the 500-level courses.

Core Courses

- GEOG 404/504: Digital Techniques for Remote Sensing 3
- GEOG 462/562: Advanced Spatial Analysis 3

Interpretive Analysis Courses 6

Select two of the following:

- BIOL 404/504: Conservation Biology
- GEOG 420/520: Marine Geography
- GEOG 422W/522: Coastal Geography
- GEOG 490/590: Applied Cartography/GIS *
- GEOG 495/595: Topics in Geography *
- OEAS 306: Oceanography
- OEAS 344W: Geomorphology
- OEAS 495/595: Special Topics *

Capstone Seminar 3

- GEOG/OEAS 419/519: Spatial Analysis of Coastal Environments

Total Hours 15

* Advanced approval required

OCEAN, EARTH AND ATMOSPHERIC SCIENCES Courses

**OEAS 106N. Introductory Oceanography. 4 Credits.**

Introductory course emphasizing the geology, chemistry, physics and biology of the oceans. Laboratory emphasizes practice of basic scientific methods. Knowledge of the metric system, scientific notation, ratio and proportion, and graphing is required. Field trip required.
OEAS 108N. Understanding Global Climate Change. 4 Credits.
What is the science behind global climate change? How reliable are forecasts of future global warming? This course examines these questions to evaluate the likelihood and potential severity of anthropogenic climate change in the coming centuries. It includes an overview of the physics of the greenhouse effect, an overview of the global carbon cycle and its role as a global thermostat; an examination of predictions and reliability of model forecasts of future climate change; and examination of local impacts of global climate change (e.g., sea level rise in the Tidewater area).

OEAS 110N. Earth Science. 4 Credits.
This is an introductory course in geological sciences. The course relates the principles of natural science to Earth as a planet, its resources, and its environment. The effects of geologic processes on the environment are stressed. A student receiving credit for OEAS 110N cannot receive credit for OEAS 111N.

OEAS 111N. Physical Geology. 4 Credits.
This course introduces the student to the study of the materials, structures, and processes of the Earth. Present terrestrial resources are interpreted in terms of the internal and surface processes that formed them. A student receiving credit for OEAS 111N cannot receive credit for OEAS 110N.

OEAS 112N. Historical Geology. 4 Credits.
The evolution of the continents, ocean basins, mountain chains, and the major life forms throughout Earth's history are studied chronologically and are related to the physical and biological changes that have caused them. Prerequisite: OEAS 110N or OEAS 111N.

OEAS 126N. Honors: Introductory Oceanography. 4 Credits.
Open only to students in the Honors College. Special honors section of OEAS 106N. In addition to broad coverage of the geology, chemistry, physics and biology of the ocean, students will read scientific papers with current environmental problems. There will be several field trips to nearby ecosystems.

OEAS 130G. Research Skills and Information Literacy for the Natural Sciences. 3 Credits.
This course is designed to introduce students to a range of research and information literacy skills necessary for natural scientists. The course will introduce students to the wide range of research being undertaken in the natural sciences (e.g., oceanography, geology, physics, biology, and chemistry). The course involves directed reading, exercises in information retrieval, and the synthesis of information from a range of sources into scientific essays and oral presentations.

OEAS 195. Topics. 1-4 Credits.
Special topics in physical, geological, chemical or biological oceanography.

OEAS 196. Topics. 1 Credit.
Special topics in physical, geological, chemical, or biological oceanography.

OEAS 220T. Introduction to Meteorology. 3 Credits.
This course is an introduction to the basic principles governing both day-to-day weather and the average of weather, or climate. Specific focus will be given to the tools used to measure weather and the ways in which these tools have impacted our understanding of weather in the past and present. Links will be made between the technology-based improvements of our understanding of weather and the impact on the lives of humans throughout recent history. Students will learn about how weather forecasts are made, and how the quality of these forecasts affects our lives.

OEAS 250N. Natural Hazards and Disasters. 4 Credits.
This course introduces the science behind some of Earth's natural phenomena that can, and often do, result in major loss of life or catastrophic damage to property. It includes an overview, with relevant case studies, of earthquakes, tsunamis, landslides, volcanic eruptions, tropical cyclones (hurricanes), tornadoes, floods, droughts, and space weather. The impact of global climate change and sea level rise on vulnerable populations is examined and current risk assessment and mitigation practices are discussed.

OEAS 295. Special Topics. 3 Credits.
An investigation of a selected problem in physical, geological, chemical, or biological oceanography. Prerequisite: sophomore standing or permission of the instructor.

OEAS 302. Environmental Geology. 3 Credits.
Geologic resources and processes that limit human activities and pose significant hazards. Does not satisfy OEAS major degree requirements. Prerequisites: junior standing and an 8-hour sequence in a General Education science course.

OEAS 303. Paleontology. 3 Credits.
This course introduces the concepts of paleontology, focusing on the relationship between the evolution of life (particularly invertebrates) and the development of Earth. Field work will also include studies in paleoecology and sedimentary facies. Two field trips are recommended. Prerequisite: OEAS 111N.

OEAS 306. Oceanography. 3 Credits.
General survey of physical, geological, chemical and biological oceanography. The application of skills from mathematics, geology, physics, biology and chemistry for the solution of oceanographic problems. Prerequisites: MATH 211 or MATH 205, BIOL 121N or BIOL 136N and BIOL 122N or BIOL 137N, CHEM 121N-CHEM 122N, OEAS 111N, and PHYS 111N or PHYS 231N.

OEAS 307. Oceanography Laboratory. 1 Credit.
Laboratory experiments designed to complement topics presented in the companion lecture course, OEAS 306. Students taking OEAS 306 are strongly encouraged to take this laboratory class concurrently with OEAS 306. Ocean and Earth Science majors are required to take this class. Prerequisites: BIOL 122N or BIOL 137N, BIOL 124N, CHEM 122N, CHEM 124N, and OEAS 111N. Pre- or corequisite: OEAS 306.

OEAS 310. Global Earth Systems. 4 Credits.
Core course for ocean and earth sciences majors that examines the processes linking the Earth's atmosphere, lithosphere, and hydrosphere into an interactive system. Prerequisites: BIOL 121N or BIOL 136N, BIOL 122N or BIOL 137N, CHEM 121N, CHEM 122N, and OEAS 111N, all with a grade of C or better.

OEAS 315. Minerals and Rocks. 4 Credits.
The course introduces the main igneous, sedimentary and metamorphic rocks and their mineral composition. Laboratory exercises include mineral identification by physical and microscopic optical properties, the identification of rocks in hand samples, and basic training with the Brunton compass. Field work includes training in introductory facies analysis, and the analysis of sedimentary rock structures, unconformities, volcanic, plutonic, and metamorphic rock units, clastics and carbonates. Prerequisites: OEAS 111N, CHEM 121N, and CHEM 122N.

OEAS 320. Sedimentology and Stratigraphy. 4 Credits.
The origin, transport, and deposition of sediments with emphasis on interpretation of sediment sequences, principles and methods of correlation. Laboratory exercises involve field sampling, textural analyses, and sedimentary structures. Field trip required. Prerequisites: OEAS 110N or OEAS 111N.

OEAS 344W. Geomorphology. 3 Credits.
Geologic processes that shape the earth's surface. Laboratory studies involve interpretation of topographic maps, soil maps, and aerial photographs. Field trip required. This is a writing intensive course. Prerequisites: OEAS 112N, OEAS 320 AND either ENGL 211C or ENGL 221C or ENGL 231C with a grade of C or better; or permission of instructor.

OEAS 367. Cooperative Education. 1-3 Credits.
Available for pass/fail grading only. Student participation for credit based on the academic relevance of the work experience, criteria, and evaluative procedures as formally determined by the department and the Career Management program prior to the semester in which the experience is to take place. Prerequisites: junior standing and permission of the department.

OEAS 368. Internship in Ocean and Earth Sciences. 1-3 Credits.
Available for pass/fail grading only. Students gain on the job work experience related to their undergraduate curriculum. Prerequisites: junior standing, permission of department and a 3.00 grade point average.

OEAS 369. Practicum. 1-3 Credits.
Field experience in ocean, earth and atmospheric sciences. (qualifies as a CAP experience) Prerequisite: junior standing, permission of department and must have declared ocean and earth sciences major or minor.
OEAS 395. 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 402/502. 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 OEAS majors and minors. Prerequisite: background in K-12 Education.

OEAS 403W/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. Prerequisites: grade of C or better in ENGL 211C, ENGL 221C, or ENGL 231C. Pre- or corequisites: a grade of C or better in OEAS 306.

OEAS 405/505. 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 406/506. Matlab. 1 Credit.
This course is designed to introduce students to Matlab programming and to develop skills utilizing this program for data analysis Prerequisites: C or better in MATH 211 or permission of instructor.

OEAS 410/510. Chemical Oceanography. 3 Credits.
Chemical composition of the ocean and the chemical, biological, geological and physical processes controlling it. Prerequisites: CHEM 121N-CHEM 122N and CHEM 123N-CHEM 124N, OEAS 306 or consent of instructor.

OEAS 411/511. Structural Geology. 4 Credits.
Recognition, habitat, and origin of deformed geologic structures. Relationships between structural patterns and tectonic settings. Laboratory sessions emphasize cartographic and stereographic projections, map interpretation, and hand sample evaluation. Weekend field trip required. Prerequisite: OEAS 320 or permission of instructor.

OEAS 412/512. 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. Prerequisites: OEAS 306 and OEAS 310.

OEAS 413/513. 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. Prerequisites: CHEM 121N-CHEM 122N and CHEM 123N-CHEM 124N, OEAS 111N and OEAS 310.

OEAS 415/515. 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 416/516. 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. Prerequisites: PHYS 232N or 112N, OEAS 306, OEAS 310, STAT 310 or STAT 330.

OEAS 418/518. Limnology: Biogeochemistry of Lakes. 3 Credits.
Chemical cycling in lakes and reservoirs, and interactions with biological and physical processes; quantitative modeling of lake geochemistry. Prerequisite: OEAS 306.

OEAS 419/519. 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). Prerequisites: GEOG 404/GEOG 504.

OEAS 420/520. 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. Prerequisites: OEAS 320, MATH 211, PHYS 111N-PHYS 112N or PHYS 231N-PHYS 232N, or permission of the instructor.

OEAS 426/526. 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 OEAS majors and minors. Prerequisite: junior standing or permission of the instructor.

OEAS 430/530. 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. Prerequisites: OEAS 111N, MATH 211, and PHYS 111N-PHYS 112N or PHYS 231N-PHYS 232N.

OEAS 434/534. 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. Corequisites: PHYS 232N, Prerequisites: OEAS 111N, MATH 211, MATH 212, and PHYS 231N.

OEAS 435. Introduction to Ocean Modeling and Prediction. 3 Credits.
Introduction to concepts and theories of numerical ocean circulation models and their applications in physical oceanography, computational fluid dynamics, environmental problems and ocean forecast systems. Prerequisites: OEAS 405 or OEAS 306; permission of instructor or CEE 330.

OEAS 440/540. 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. Prerequisites: OEAS 306 and STAT 130M or STAT 310.

OEAS 441. Ocean and Earth Sciences Field Study I. 3 Credits.
Interdisciplinary investigation of selected sites in Southeast Virginia that includes field sampling, sample analyses, data interpretation and integration, and group report preparation and presentations. Focuses on development of research questions and site selection, field sampling, sample analyses and interpretation. Oral presentations of results will be made by each student. Prerequisites: OEAS 306 and OEAS 310; CHEM 123N and CHEM 124N, BIOL 123N or OEAS 303; PHYS 112N or PHYS 232N; MATH 212; STAT 310; all prerequisite courses must be passed with a grade of C or better.
OEAS 442W. Ocean and Earth Sciences Field Study II. 3 Credits.
Interdisciplinary investigation of selected sites in Southeast Virginia that includes field sampling, sample analyses, data interpretation and integration, and group report preparation and presentations. Focuses on site selection and evaluation mapping, sampling, and sample analyses. Oral presentations of results will be made by each student. This is a writing intensive course. Prerequisites: a grade of C or better in ENGL 211C or ENGL 221C or ENGL 231C; OEAS 441.

OEAS 444. Communicating Ocean Science to Informal Audiences. 3 Credits.
This course provides Earth Science Education students with instruction on presenting scientific information to informal audiences (K through adult). The course provides techniques and practical experience in designing informal lessons. For Earth Science Education track students, OEAS 444 and OEAS 445 can replace OEAS 441/OEAS 442W. It is available as an elective for all other students. Prerequisites: OEAS 306 or OEAS 310.

OEAS 445. Communicating Ocean Science to Informal Audiences. 3 Credits.
This course provides Earth Science Education students with instruction on presenting scientific information to informal audiences (K through adult). Students will develop more in-depth presentations and extended practice presenting their materials on the Virginia Aquarium floor. For Earth Science Education track students, OEAS 444 and OEAS 445 can replace OEAS 441/OEAS 442W. It is available as an elective for all other students. Prerequisite: OEAS 444.

OEAS 446/546. Quaternary Geology. 3 Credits.
Geological effects of Cenozoic climate changes and tectonic movements on marine and terrestrial systems. Weekend field trips to study landscapes and deposits in the coastal plain and Appalachian provinces. Prerequisite: OEAS 344W.

OEAS 448/548. Population Ecology. 3 Credits.
This course uses conceptual and mathematical models to understand how populations grow and persist in space and time. Both plants and animals are discussed. Prerequisite: MATH 211.

OEAS 451W/551. Data Collection and Analysis in Oceanography. 4 Credits.
This course introduces students to the basic numerical tools used to obtain and analyze information in the ocean and earth sciences. The students will use various oceanographic instruments to obtain data at different locations of the Chesapeake Bay. Data obtained with those instruments will be processed and analyzed using 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. This is a writing intensive class. Prerequisites: OEAS 310 and MATH 211. Pre- or corequisite: OEAS 306.

OEAS 452. Microbial Ecology of the Oceans. 3 Credits.
Marine microbes thrive in all oceanic habitats including what would be considered extreme environmental conditions. This course studies the role that these microbes play in biogeochemical cycling and food web dynamics in the oceans (the microbial loop). Throughout the course, students will learn about different microbial functional groups and the processes they mediate in marine systems, which include virtually all geochemical reactions occurring in the oceans. Students will learn through lectures, readings written by experts in the field, and class discussions. Prerequisite: OEAS 306 or OEAS 310 or permission of the instructor.

OEAS 453W/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. This is a writing intensive course. Prerequisite: BIOL 291 or BIOL 292 or BIOL 293 or BIOL 303 or BIOL 331 or OEAS 306.

OEAS 466W/566. Introduction to Mitigation and Adaptation Studies. 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. This is a writing intensive course. Cross listed with BIOL 466W and IDS 466W. Prerequisite: BIOL 291 or permission of instructor.

OEAS 467/567. 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 466W or OEAS 466W or IDS 466W.

OEAS 468W. Research Methods in Math and Sciences. 3 Credits.
Emphasizes the tools and techniques used to solve scientific problems. Topics include use and design of experiments, use of statistics to interpret experimental results, mathematical modeling of scientific phenomena, and oral and written presentation of results. Students will perform four independent inquiries, combining skills from mathematics and science to solve research problems. This is a writing intensive course. Prerequisites: A grade of C or better in ENGL 211C or ENGL 221C or ENGL 231C and OEAS 306 or OEAS 310 and STEM 201.

OEAS 487. Honors Research in Ocean and Earth Sciences. 1-3 Credits.
Supervised study in a field of individual interest. Research results are reported in a public oral presentation and a thesis. Prerequisite: senior standing and admission to the Academic Honors Program.

OEAS 490. Paleooceanography. 3 Credits.
This course will provide an overview of how marine sediments are used to reconstruct Earth’s climate history over the past 600 million years. Students will discuss the factors that control modern climate and explore how these variables led to cycles of Greenhouse and Icehouse worlds in the past. Finally, students will discuss how past and modern climate records can be used to predict future climate change. Prerequisites: general chemistry, OEAS 111N and OEAS 112N.

OEAS 495/595. Special Topics. 1-4 Credits.
Lectures, field and laboratory studies. An investigation of a selected problem in physical, geological, chemical, or biological oceanography. Prerequisites: junior standing and permission of the instructor.

OEAS 497. Special Problems and Research. 1-3 Credits.
Independent reading and study on a topic to be selected with the direction of an instructor. Prerequisite: junior standing.