Ocean, Earth and Atmospheric Sciences

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

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

The Department of Ocean, Earth and Atmospheric Sciences offers an undergraduate major in Ocean and Earth science. Undergraduate majors select one of five concentrations (biological oceanography, chemical oceanography, physical oceanography, geology, 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 national, state and local philanthropic sources, as well as from private industry and the Commonwealth's 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, Earth, and Atmospheric 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.

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 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.

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.

Earth Science Education Concentration

The Earth science education endorsement 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>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 121N &amp; CHEM 122N</td>
<td>Foundations of Chemistry I Lecture and Foundations of Chemistry I Laboratory (required)</td>
<td>8</td>
</tr>
<tr>
<td>CHEM 123N &amp; CHEM 124N</td>
<td>Foundations of Chemistry II Lecture and Foundations of Chemistry II Laboratory (required)</td>
<td>8</td>
</tr>
<tr>
<td>OEAS 441 or OEAS 444</td>
<td>Communicating Ocean Science to Informal Audiences</td>
<td>4</td>
</tr>
<tr>
<td>MATH 211</td>
<td>Calculus I (required)</td>
<td>0-6</td>
</tr>
<tr>
<td>Information Literacy and Research</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Interpreting the Past</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Literature</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Philosophy and Ethics</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>The Nature of Science</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Impact of Technology (met in the major by OEAS 220T for earth science education)</td>
<td>0-3</td>
<td></td>
</tr>
<tr>
<td>Human Behavior</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Total Hours</td>
<td>36-45</td>
<td></td>
</tr>
</tbody>
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Students must select one of the following options:

Course Requirements – Biological Oceanography Concentration

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 121N</td>
<td>General Biology I</td>
<td>3</td>
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</table>
### Course Requirements – Chemical Oceanography Concentration

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
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<tr>
<td>BIOL 121N</td>
<td>General Biology I</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 122N</td>
<td>General Biology I Lab</td>
<td>1</td>
</tr>
<tr>
<td>BIOL 123N</td>
<td>General Biology II</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 124N</td>
<td>General Biology II Lab</td>
<td>1</td>
</tr>
<tr>
<td>OEAS 406</td>
<td>Matlab</td>
<td>1</td>
</tr>
<tr>
<td>OEAS 440</td>
<td>Biological Oceanography</td>
<td>4</td>
</tr>
<tr>
<td>BIOL 292</td>
<td>Evolution</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 415W</td>
<td>Marine Ecology or OEAS 451 Data Collection and</td>
<td>4-5</td>
</tr>
<tr>
<td></td>
<td>Analysis in Oceanography</td>
<td></td>
</tr>
<tr>
<td>CHEM 211</td>
<td>Organic Chemistry Lecture</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 212</td>
<td>Organic Chemistry Laboratory</td>
<td>2</td>
</tr>
<tr>
<td>CHEM 213</td>
<td>Organic Chemistry Lecture</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 441</td>
<td>Biochemistry Lecture</td>
<td>3</td>
</tr>
</tbody>
</table>

Select two of the following electives:  

- OEAS 403W Aquatic Pollution  
- OEAS 404 Environmental Physiology of Marine Animals  
- OEAS 405 Physical Oceanography  
- OEAS 410 Chemical Oceanography  
- OEAS 412 Global Environmental Change  
- OEAS 416 Electronics and Oceanographic Instrumentation  
- OEAS 420 Hydrogeology  
- OEAS 448 Population Ecology  
- OEAS 451 Data Collection and Analysis in Oceanography (if not taken in lieu of BIOL 451)  
- OEAS 452 Microbial Ecology of the Oceans  
- OEAS 453 Marine Molecular Ecology  
- OEAS 441 & OEAS 442W Ocean and Earth Sciences Field Study I and Field Study II (satisfies oral and upper-division written communication requirement)  

Total Hours: 68-69

### Course Requirements – Physical Oceanography Concentration

<table>
<thead>
<tr>
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<th>Title</th>
<th>Hours</th>
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</thead>
<tbody>
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<td>BIOL 121N</td>
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</tr>
<tr>
<td>BIOL 122N</td>
<td>General Biology I Lab</td>
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</tr>
<tr>
<td>BIOL 123N</td>
<td>General Biology II</td>
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</tr>
<tr>
<td>BIOL 124N</td>
<td>General Biology II Lab</td>
<td>1</td>
</tr>
<tr>
<td>OEAS 111N</td>
<td>Physical Geology</td>
<td>4</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>and University Physics</td>
<td></td>
</tr>
<tr>
<td>OEAS 310</td>
<td>Global Earth Systems</td>
<td>3</td>
</tr>
<tr>
<td>STAT 310</td>
<td>Introductory Data Analysis</td>
<td>3</td>
</tr>
<tr>
<td>OEAS 406</td>
<td>Matlab</td>
<td>1</td>
</tr>
<tr>
<td>OEAS 410</td>
<td>Chemical Oceanography</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 211</td>
<td>Organic Chemistry Lecture</td>
<td>6</td>
</tr>
<tr>
<td>&amp; CHEM 213</td>
<td>and Organic Chemistry Lecture</td>
<td></td>
</tr>
<tr>
<td>CHEM 331</td>
<td>Physical Chemistry Lecture</td>
<td>6</td>
</tr>
<tr>
<td>&amp; CHEM 333</td>
<td>and Physical Chemistry Lecture II</td>
<td></td>
</tr>
<tr>
<td>CHEM 332W</td>
<td>Experimental Physical Chemistry I</td>
<td>2</td>
</tr>
<tr>
<td>or CHEM 452</td>
<td>Advanced Inorganic Chemistry Laboratory</td>
<td></td>
</tr>
<tr>
<td>CHEM 351</td>
<td>Inorganic Chemistry</td>
<td>3</td>
</tr>
</tbody>
</table>

Select two of the following electives:  

- OEAS 403W Aquatic Pollution  
- OEAS 412 Global Environmental Change  
- OEAS 413 Environmental Geochemistry  
- OEAS 418 Chemical Limnology  
- OEAS 451 Data Collection and Analysis in Oceanography  
- OEAS 441 & OEAS 442W Ocean and Earth Sciences Field Study I and Field Study II (satisfies oral and upper-division written communication requirement)  

Total Hours: 66

### Course Requirements – Ocean, Earth and Atmospheric Sciences

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 121N</td>
<td>General Biology I</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 122N</td>
<td>General Biology I Lab</td>
<td>1</td>
</tr>
<tr>
<td>BIOL 123N</td>
<td>General Biology II</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 124N</td>
<td>General Biology II Lab</td>
<td>1</td>
</tr>
<tr>
<td>OEAS 406</td>
<td>Matlab</td>
<td>1</td>
</tr>
<tr>
<td>OEAS 410</td>
<td>Chemical Oceanography</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 211</td>
<td>Organic Chemistry Lecture</td>
<td>6</td>
</tr>
<tr>
<td>&amp; CHEM 213</td>
<td>and Organic Chemistry Lecture</td>
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<tr>
<td>CHEM 331</td>
<td>Physical Chemistry Lecture</td>
<td>6</td>
</tr>
<tr>
<td>&amp; CHEM 333</td>
<td>and Physical Chemistry Lecture II</td>
<td></td>
</tr>
<tr>
<td>CHEM 332W</td>
<td>Experimental Physical Chemistry I</td>
<td>2</td>
</tr>
<tr>
<td>or CHEM 452</td>
<td>Advanced Inorganic Chemistry Laboratory</td>
<td></td>
</tr>
<tr>
<td>CHEM 351</td>
<td>Inorganic Chemistry</td>
<td>3</td>
</tr>
</tbody>
</table>

Select two electives from one of the following three option areas:  

**Option A**  
- GEOG 404 Digital Techniques for Remote Sensing  
- GEOG 419 Spatial Analysis of Coastal Environments  
- GEOG 432 Advanced GIS  
- OEAS 430 Introduction to Geophysics  
- OEAS 466W Introduction to Mitigation and Adaptation Studies  
- Ocean and Earth Sciences Field Study I and Field Study II (satisfies oral and upper-division written communication requirement)  

**Option B**  
- MATH 401 Partial Differential Equations  
- MATH 408 Applied Numerical Methods I  
- MATH 457 Mathematics in Nature  
- OEAS 430 Introduction to Geophysics  

Total Hours: 66
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 Teacher Education Services website at www.odu.edu/tes.

**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 satisfy the Virginia Board of Education Required Assessment for Admission to an Approved Teacher Education Program. This requirement can be satisfied by meeting a passing score in one of the selected criteria below:

1. Passing Praxis I composite score of 532 by December 31, 2013; or
2. Passing Praxis Core Academic Skills Tests beginning January 1, 2014: Reading Score of 156, Writing Score of 162, and Mathematics Score of 150; or
3. Approved substitute test scores:
   a. SAT score of 1000 with at least 450 verbal and 510 mathematics taken prior to April 1, 1995; or
   b. SAT score of 1100 with at least 530 verbal and 530 mathematics taken after April 1, 1995 and before March 2016; or
   c. SAT score of 1170 with at least 580 evidence-based reading and writing and 560 mathematics taken after March 1, 2016; or
   d. ACT composite score of 21 with ACT mathematics score of at least 21, and ACT English plus Reading score of at least 37, taken prior to April 1, 1995; or
e. ACT composite score of 24 with ACT mathematics score of at least 22, and ACT English plus Reading score of at least 46, taken after April 1, 1995; or
f. Praxis I Math test score of 178 by December 31, 2013 and a composite Virginia Communication and Literacy Assessment (hereafter referred to as the VCLA) score of 470; or
g. Praxis Core Academic Skills Mathematics test score of 150 beginning January 1, 2014 and a VCLA score of 470; or
h. SAT Mathematics test score of at least 510 taken prior to April 1, 1995 and a VCLA score of 470; or
i. SAT Mathematics test score of at least 530 taken after April 1, 1995 and a composite VCLA score of 470; or
j. SAT Mathematics test score of at least 560 taken after March 1, 2016 and a composite VCLA score of 470; or
k. ACT Mathematics test score of at least 21 taken prior to April 1, 1995 and a composite VCLA score of 470; or
l. ACT Mathematics test score of at least 22 taken after April 1, 1995 and a composite VCLA score of 470.

Note: ACT scores taken prior to 1989 are not valid.

For the most current information on the prescribed Virginia Board of Education admission assessment, visit the Teacher Education Services website, http://www.odu.edu/tes and review the Teacher 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 Teacher Education Services.

**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. 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**

- 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 Teacher Education Services website, www.odu.edu/tes.

**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>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 121N</td>
<td>General Biology I</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 122N</td>
<td>General Biology I Lab</td>
<td>1</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>and 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 220T</td>
<td>Introduction to Meteorology</td>
<td>3</td>
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<tr>
<td>OEAS 306</td>
<td>Oceanography</td>
<td>3</td>
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<tr>
<td>OEAS 310</td>
<td>Global Earth Systems</td>
<td>3</td>
</tr>
<tr>
<td>OEAS 303</td>
<td>Paleontology</td>
<td>3</td>
</tr>
<tr>
<td>OEAS 315</td>
<td>Minerals and Rocks</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>
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<tr>
<td>OEAS 441 &amp;</td>
<td>Ocean and Earth Sciences Field Study I</td>
<td>6</td>
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<tr>
<td>OEAS 442W</td>
<td>and Ocean and Earth Sciences Field Study II</td>
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<tr>
<td></td>
<td>(satisfies oral and upper-division written</td>
<td></td>
</tr>
<tr>
<td></td>
<td>requirement.)</td>
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</tr>
<tr>
<td>or</td>
<td>OEAS 444 &amp; OEAS 468W</td>
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<tr>
<td></td>
<td>Communicating Ocean Science to Informal</td>
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<tr>
<td></td>
<td>Audiences and Research Methods in Math and</td>
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</tr>
<tr>
<td></td>
<td>Sciences (an alternative to OEAS 441-442W for</td>
<td></td>
</tr>
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<td></td>
<td>the Earth science education emphasis; satisfies</td>
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</tr>
<tr>
<td></td>
<td>oral communication requirement)</td>
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</tr>
<tr>
<td>Total Hours</td>
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<td>51</td>
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</table>

**The Professional Education core courses and requirements are as follows:**

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<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEM 101</td>
<td>Step 1 – Inquiry Approaches to Teaching STEM</td>
<td>1</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>
</tbody>
</table>

Ocean, Earth and Atmospheric Sciences 4
Ocean and Earth Science Minor

Juniors and seniors with declared majors in biology, biochemistry, chemistry, computer science, engineering, mathematics or physics are eligible to enter the minor program in ocean and Earth science. Specific course prerequisites will be strictly enforced and students with majors in other disciplines should consult with the OEAS chief departmental advisor before applying to the program. 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 OEAS 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.

Students must receive a C or better in each course taken for the minor including prerequisites, and a minimum of six credit hours must be completed at 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). 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 certificate complete the 400-level courses, and those seeking graduate certification complete the 500-level courses.

<table>
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<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
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</thead>
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<tr>
<td>GEOF 404/504</td>
<td>Digital Techniques for Remote Sensing</td>
<td>3</td>
</tr>
<tr>
<td>GEOF 462/562</td>
<td>Advanced Spatial Analysis</td>
<td>3</td>
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Select two of the following:

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

**Capstone Seminar**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
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<tr>
<td>GEOF/OEAS 419/519</td>
<td>Spatial Analysis of Coastal Environments</td>
<td>3</td>
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</table>

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, and biology of the ocean, students will read scientific papers with current environmental problems. There will be several field trips to nearby ecosystems.

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 210. Environmental Earth Science. 4 Credits.
Dynamic processes of the land, ocean, and atmosphere and how they affect people. Topics include plate tectonics; rocks and minerals; soil and water; weather and climate; tides and currents; limits to natural resources. Does not satisfy OEAS major requirements.

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), tornados, 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. Topics include: the concept of time; taphonomy and fossil types; fossil Lagerstatten; biomineralization; functional morphology and bauplans; palaeontological versus biological species concept; biofilms; morphospace and adaptive landscapes; evolution of main invertebrate groups; paleoecology; extinction dynamics; and human evolution and the Anthropocene. Two field trips are recommended. Prerequisite: OEAS 112N.

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, BIOL 121N and BIOL 122N, CHEM 121N-CHEM 122N, OEAS 111N, and PHYS 111N or PHYS 231N.

OEAS 310. Global Earth Systems. 3 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 and BIOL 122N, CHEM 121N-CHEM 122N, MATH 211, and OEAS 111N.

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. Selected Topics. 3 Credits.
A nonmathematical course based on topics such as urban geology, urban biometeorology, and intelligent life in the universe. Specific topics will be announced each semester. Prerequisite: completion of 8 hours of a laboratory science.

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 404/504. Environmental Physiology of Marine Animals. 3 Credits.
Functional morphology and physiological aspects of growth and ecological energetics of marine animals. Basic concepts and habitat comparisons. Prerequisite: junior standing; upper level biology courses.

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 408/508. Introductory Soils. 4 Credits.
Nature and properties of soils. Physical and chemical processes in soils and their influence on plant growth, the movement of water, and pollutants. Importance of soil properties in determining urban, industrial and agricultural uses. Prerequisite: CHEM 121N-CHEM 122N and CHEM 123N-CHEM 124N.

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.
Low temperature geochemistry of surface and near-surface materials and processes. Weathering and the geochemical cycle as influenced by environment. Prerequisites: CHEM 121N-CHEM 122N and CHEM 123N-CHEM 124N and OEAS 111N.

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. Chemical Limnology. 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 431/531. Sedimentary Petrology. 3 Credits.
The chemical aspects of sediments and sedimentary rock needed for modern geologic and oceanographic studies. Optical petrology and x-ray diffraction are emphasized in the laboratory with particular attention to clay mineralogy. Field trip required. Prerequisite: OEAS 320.

OEAS 432. Introduction to Thermo- and Fluid Dynamics for Oceanographers. 3 Credits.
The objective of this course is to impart the basic knowledge of thermo- and fluid dynamics required to understand these concepts and theories in physical oceanography. Prerequisite: MATH 211, MATH 212, PHYS 231N and 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. Corequisite: 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 106N, OEAS 126N or 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. Prerequisites: 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 451/551. 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 be used to test a particular hypothesis related to the temporal and spatial variability in a natural system. Prerequisites: OEAS 306 or OEAS 310, MATH 211, MATH 212 and STAT 310.

OEAS 452. Microbial Ecology of the Oceans. 4 Credits.
This course studies the role that microbes play in biogeochemical cycling and food web dynamics in the oceans (the microbial loop). The course will include lectures, group discussions of primary literature, and laboratory experiments. Laboratory exercises will include traditional microbial ecology and molecular ecology. Students will learn skills useful to oceanography field work. Prerequisite: OEAS 306 or permission of the instructor.

OEAS 453/553. 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. Prerequisite: BIOL 291 or BIOL 292 or BIOL 293 or BIOL 303 or BIOL 331 or OEAS 306.

OEAS 466W/S66. 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 local and global 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.

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 488. 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. Paleoeceanography. 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.