

COLLEGE OF EARTH, OCEAN, AND ATMOSPHERIC SCIENCES

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College of Earth, Ocean, and Atmospheric Sciences (CEOAS)

The College of Earth, Ocean, and Atmospheric Sciences (CEOAS) has a three-fold mission: to pursue basic and applied research; educate and train undergraduate and graduate students; and to extend information to

society about Earth, oceans and atmosphere, including their interactions and the interrelationships with humans and ecosystems.

The college prepares students for professional careers and enables faculty to seek out new ideas and innovative approaches to the complex issues of planetary-scale science.

Please see <http://ceoas.oregonstate.edu/> for more information about the college.

History

In 2011, the College of Earth, Ocean, and Atmospheric Sciences was created by the merger of the College of Oceanic and Atmospheric Sciences (COAS), the Department of Geosciences and the Environmental Sciences Undergraduate Program in the College of Science. The college is at the heart of a new research and education enterprise organized around the interdisciplinary sciences of the Earth, ocean, and atmosphere. It spans the natural science disciplines and creates strong linkages with the social sciences both within the college as well as around the university.

The college is Oregon's principal source of expert knowledge about the Earth, ocean, and the atmosphere, especially in the Pacific Northwest region, which has long been the focus of major research efforts by OSU researchers. It conducts the only comprehensive oceanographic and atmospheric research programs in Oregon, as well as major programs in geology, geography, and geospatial studies. Today, research activities of the college extend throughout the world and to all oceans. Its graduates hold professional and leadership positions in science, resource management, education, regulatory agencies, and the private sector in the United States and internationally.

The new college has celebrated 100 years of excellence in the Geology program while establishing new degree options in ocean and climate science. The college has diversified and increased general education courses and offers certificates in geospatial studies and water conflict management and transformation. The college fosters experiential learning through labs, field, and shipboard experiences.

Faculty

Professors Barnes, Barth, Becker, Benoit-Bird, Bloomer, Brook, Campana, Cianelli, Clark, Colwell, Conway, Crump, Davis, de Silva, Dever, Dilles, Egbert, Goldfinger, Goñi, Graham, Haggerty, Hales, Haller, Harris, Harte, Jones, Kent, Koppers, Kosro, Letelier, Lyle, Matano, Marinelli, Meigs, Mellinger, Mix, Mote, Moum, Nabelek, Nash, Nielsen, Nolin, Noone, Özkan-Haller, Reimers, Samelson, Schultz, Skyllingstad, Smyth, Spitz, Torres, Trehu, Wheatcroft, Wolf

Associate Professors Carlson, Corcoran, de Szoeko, Gosnell, Haley, Kirby, Kurapov, Lancaster, Lerczak, Matsumoto, Ruggiero, Santelmann, Schmittner, Shearman, Shell, Stoner, Tepley, Tufillaro, Waldbusser, White

Assistant Professors Bernard, Buizert, Copeman, Creveling, Durland, Fehrenbacher, Fram, Haxel, Hutchings, Jarvis, Juranek, Kennedy, McKay, O'Neill, Rupp, Shiel, Shroyer, Thurber, Tilt, Van Den Hoek, Wettstein, Wilson, Wrathall, Zhao

Senior Instructors L. Becker, Cook, Hommel, K. Yalcin

Instructors Hyrapiet, Keller, Milstein, Nelson, R. Yalcin

Academic Advisors Chuinard (head advisor), Gaid, Lieuallen, Menn

Experiential Learning Coordinator Cardinal-Lanier

Emeriti

Allen, Bennett, Byrne, Caldwell, Carey, Chelton (Distinguished) Coakley, Collier, Couch, Cowles, Dalrymple, Deardorff, de Szoeki, Dillon, Duncan, Esbensen, Fisk, Frenkel, Gates, Gonor, Good, Gordon (Associate), Grunder, Holman, Huyer, Jackson, Keller, Kimerling, Klinkhammer, Komar, Kulm, Lawrence, Levi, Lillie, Mahrt, Maresh, Matzke, Miller, R. Miller, Morris, Muckleston, Nelson, Neshyba, Niem, Nolan, Paulson, Percy, Pease, Pillsbury (Associate), Piasis, Prah, Rosenfeld, B. Sherr, E. Sherr, Simoneit, Small, Smith, Strub, Taylor, Unsworth, Vong, Wheeler (Distinguished), Yeats, Zaneveld

Please see the college website at <http://ceoas.oregonstate.edu> for updated listings that include adjunct faculty, research faculty, courtesy faculty, and research associates.

Requirements for Undergraduate Programs in the College

The University Baccalaureate Core requirements are explained in a separate section, "Earning a Degree at Oregon State University". The major and option requirements are explained below. If you want to add a minor program or certificate, you will also need to complete the requirements for that minor or certificate. Specific requirements for interdisciplinary minors are listed in the Interdisciplinary Programs section of this catalog.

Academic Advising

Undergraduates within CEOAS are assigned a professional advisor based on the student's major program of study. Advisors help to monitor academic progress through the degree programs, assist students with defining goals within the major, help in navigating university policies and regulations, and provide referrals to campus-wide resources. Faculty within CEOAS are involved as mentors for undergraduates—to guide students on professional and career-related decisions and to help connect students with research opportunities.

Internships and Experiential Learning

CEOAS places a strong emphasis in gaining experience outside of the classroom and offers specialized support to all students for internships and undergraduate research through a designated experiential learning coordinator available to all undergraduates within the college.

Teacher Education

The Earth Sciences and Environmental Sciences majors provide excellent scientific preparation for teaching middle school and high school science. All professional teacher licensure certification occurs in the College of Education.

Double Degrees

Undergraduates with majors in CEOAS can earn a second degree in education, innovation management, international studies, or sustainability. See the College of Education, College of Business, International Programs or Department of Forest Ecosystems and Society sections of this catalog for more information.

College Undergraduate Graduation Requirements

Along with fulfilling the university-level, baccalaureate core, and major requirements for BS degrees within CEOAS, students must meet the following college requirements:

- A grade of at least C– minus is required for all upper-division (300 level and above) courses taken to fulfill major requirements.
- A minimum 2.00 GPA in major requirement courses (excluding baccalaureate core and electives) is required for all CEOAS majors.
- "S/U" grading is not allowed for courses taken to fulfill major requirements.

Requirements for Admission to the Graduate Programs in the College

1. A bachelor's degree with a major (40 quarter credits or more) in a relevant discipline (see individual program requirements) such as physics, mathematics, chemistry, biology, geology, atmospheric science, computer science, or engineering. Geography and Marine Resource Management applicants also have a bachelor's degree in the social or political sciences, geography, economics, business administration, or fisheries.
2. A minimum cumulative grade-point average of 3.00 on a 4.00 scale for the last 90 quarter credits of undergraduate work.
3. A solid foundation in prerequisites (see individual program requirements).
4. Graduate Record Examination (GRE) scores (general).
5. Three letters of recommendation.
6. For TOEFL requirements, please see the OSU Admissions Web pages for graduate requirements and contact the CEOAS Student Services Office for specific information.

Early January is the deadline to apply for the following fall term admission. Early application is strongly recommended.

Master's Programs

All students in College of Earth, Ocean, and Atmospheric Sciences graduate majors must satisfy the minimum program requirements (45 credits including 6 credits of thesis) established by the Graduate School. Some graduate credits earned at other institutions may be approved for inclusion in the program. The Marine Resource Management graduate program requires additional course work credits. Please contact the Student Services for more information.

A two-hour, final oral examination is required for completion of the master's program (thesis option only).

Doctor of Philosophy Program

The content of PhD programs, other than core requirements, is determined by individual students and their committees. Specific university requirements are formulated by the Graduate School. Approximately 80 credits of courses in the graduate major (including the core courses and 30 to 35 credits of thesis) are usually included in the major. The dissertation is based on an original investigation in some area of the graduate major.

One year of courses taken as a part of a master's program is normally transferable into the PhD program.

Undergraduate Programs

Majors

- Earth Sciences (<http://catalog.oregonstate.edu/college-departments/earth-ocean-atmospheric-sciences/earth-sciences-bs-hbs>)
 - Options:**
 - *Climate Science*
 - *Geology*
 - *Ocean Science*
- Environmental Sciences (<http://catalog.oregonstate.edu/college-departments/earth-ocean-atmospheric-sciences/environmental-sciences-bs-hbs>)
 - Options:**
 - *Alternative Energy*
 - *Applied Ecology*
 - *Aquatic Biology*
 - *Conservation, Resources, and Sustainability*
 - *Earth Systems*
 - *Environmental Agriculture*
 - *Environmental Policy and Economics*
 - *Environmental Science Education*
 - *Environmental Water Resources*
- Geography and Geospatial Science (<http://catalog.oregonstate.edu/college-departments/earth-ocean-atmospheric-sciences/geography-geospatial-science-bs-hbs>)

Minors

- Earth Sciences (<http://catalog.oregonstate.edu/college-departments/earth-ocean-atmospheric-sciences/earth-sciences-minor>)
- Environmental Sciences (<http://catalog.oregonstate.edu/college-departments/earth-ocean-atmospheric-sciences/environmental-sciences-minor>)
- Geography (<http://catalog.oregonstate.edu/college-departments/earth-ocean-atmospheric-sciences/geography-minor>)
- Geology (<http://catalog.oregonstate.edu/college-departments/earth-ocean-atmospheric-sciences/geology-minor>)
- Oceanography (<http://catalog.oregonstate.edu/college-departments/earth-ocean-atmospheric-sciences/oceanography-minor>)

Certificates

- Geographic Information Science (<http://catalog.oregonstate.edu/college-departments/earth-ocean-atmospheric-sciences/geographic-information-science-certificate>)

Graduate Programs

Majors

- Geography (<http://catalog.oregonstate.edu/college-departments/earth-ocean-atmospheric-sciences/geography-ma-ms-phd>)
- Geology (<http://catalog.oregonstate.edu/college-departments/earth-ocean-atmospheric-sciences/geology-ma-ms-phd-mais>)
- Marine Resource Management (<http://catalog.oregonstate.edu/college-departments/earth-ocean-atmospheric-sciences/marine-resource-management-ma-ms>)
- Ocean, Earth and Atmospheric Sciences (<http://catalog.oregonstate.edu/college-departments/earth-ocean-atmospheric-sciences/ocean-earth-atmospheric-sciences-ma-ms-phd-mais>)

atmospheric-sciences/ocean-earth-atmospheric-sciences-ma-ms-phd-mais)

Minors

- Geography (<http://catalog.oregonstate.edu/college-departments/earth-ocean-atmospheric-sciences/geography-graduate-minor>)
- Geology (<http://catalog.oregonstate.edu/college-departments/earth-ocean-atmospheric-sciences/geology-graduate-minor>)
- Marine Resource Management (<http://catalog.oregonstate.edu/college-departments/earth-ocean-atmospheric-sciences/marine-resource-management-graduate-minor>)
- Ocean, Earth and Atmospheric Sciences (<http://catalog.oregonstate.edu/college-departments/earth-ocean-atmospheric-sciences/ocean-earth-atmospheric-sciences-graduate-minor>)
- Risk and Uncertainty Quantification in Earth Systems (<http://catalog.oregonstate.edu/college-departments/earth-ocean-atmospheric-sciences/risk-uncertainty-quantification-earth-systems-graduate-minor>)
- Water Conflict Management and Transformation (<http://catalog.oregonstate.edu/college-departments/earth-ocean-atmospheric-sciences/water-conflict-management-transformation-graduate-minor>)

Certificates

- Geographic Information Science (<http://catalog.oregonstate.edu/college-departments/earth-ocean-atmospheric-sciences/geographic-information-science-graduate-certificate>)
- Water Conflict Management and Transformation (<http://catalog.oregonstate.edu/college-departments/earth-ocean-atmospheric-sciences/water-conflict-management-transformation-graduate-certificate>)
- Marine Resource Management (<http://catalog.oregonstate.edu/college-departments/earth-ocean-atmospheric-sciences/marine-resource-management-graduate-certificate>)

Atmospheric Sciences

ATS 201. *CLIMATE SCIENCE. (4 Credits)

Physical laws governing the Earth's climate and their interactions with chemical and biological processes on land and in the atmosphere, oceans, and cryosphere. Past, present, and potential future climate changes due to natural and human causes are assessed using a variety of observations, models, and laboratory exercises. (Bacc Core Course)

Attributes: CPPS – Core, Pers, Physical Science

ATS 295. OBSERVING CLIMATE. (3 Credits)

One-week course taught during Spring Break at field sites near Corvallis, with ten hours of preparatory meetings on campus. Make and analyze observations of properties of the atmosphere, ocean, biosphere, and cryosphere that reflect processes relevant to regional and global climate. Serves as an introduction to upper-division course work in climate science. Field trip(s) required; transportation fee charged. Lec/lab.

Prerequisites: ATS 201 with C- or better or ATS 320 with C- or better

ATS 301. CLIMATE DATA ANALYSIS. (4 Credits)

Quantitative methods to characterize the physical climate system and detect change. Interpret data based on source timescale, and statistics; communicate conclusions and uncertainties regarding past climate and future changes.

Prerequisites: ATS 201 with C- or better and ST 351 [C-]

ATS 310. METEOROLOGY. (4 Credits)

The study of the atmosphere, in particular atmospheric phenomena that we experience as weather. Key physical concepts in meteorology are introduced and explored. The physics of the atmosphere necessary to understand why atmospheric phenomena occur and how these are forecast is discussed. Meteorological data from observations and models will be analyzed to explore concepts introduced in the context of the weather we experience. Lec/Lab.

Prerequisites: (MTH 251 with C- or better or MTH 251H with C- or better) and (PH 201 [D-] or PH 201H [D-] or PH 211 [D-] or PH 211H [D-]) and (PH 202 (may be taken concurrently) [D-] or PH 202H (may be taken concurrently) [D-] or PH 212 (may be taken concurrently) [D-] or PH 212H (may be taken concurrently) [D-] or CH 121 (may be taken concurrently) [D-] or CH 231 (may be taken concurrently) [D-] or CH 231H (may be taken concurrently) [D-])

ATS 399. SPECIAL TOPICS. (1-16 Credits)

Equivalent to: ATS 399H

This course is repeatable for 12 credits.

ATS 399H. SPECIAL TOPICS. (1-16 Credits)

Attributes: HNRS – Honors Course Designator

Equivalent to: ATS 399

This course is repeatable for 12 credits.

ATS 401. RESEARCH. (1-16 Credits)

This course is repeatable for 24 credits.

ATS 403. THESIS. (1-16 Credits)

This course is repeatable for 24 credits.

ATS 405. READING AND CONFERENCE. (1-16 Credits)

This course is repeatable for 16 credits.

ATS 406. PROJECTS. (1-16 Credits)

This course is repeatable for 24 credits.

ATS 407. SEMINAR. (1 Credit)

One-credit sections. Graded P/N.

This course is repeatable for 12 credits.

ATS 408. WORKSHOP. (0-12 Credits)

May be repeated for credit when topic varies.

This course is repeatable for 12 credits.

ATS 410. INTERNSHIP. (1-12 Credits)

Pre-career professional experience under joint faculty and employer supervision. Graded P/N.

This course is repeatable for 48 credits.

Recommended: 12 credits of upper-division college courses

ATS 411. THERMODYNAMICS AND CLOUD MICROPHYSICS. (4 Credits)

Thermodynamic processes in the atmosphere, and an introduction to cloud microphysics. Offered annually.

Prerequisites: (MTH 254 with D- or better or MTH 254H with D- or better) and PH 213 [D-]

ATS 412. ATMOSPHERIC RADIATION. (3 Credits)

Radiative transfer in the earth and planetary atmospheres, absorption and scattering of sunlight, absorption and emission of terrestrial radiation, absorption and scattering cross sections for molecules, cloud droplets and aerosols. Applications include enhancement of photochemical reaction rates in clouds, remote sensing, and the earth's radiation budget, radiative-convective equilibrium, radiative forcing due to changes in atmospheric composition and climate change.

Prerequisites: (MTH 254 with D- or better or MTH 254H with D- or better) and (MTH 256 [D-] or MTH 256H [D-]) and PH 213 [D-]

ATS 413. ATMOSPHERIC CHEMISTRY. (3 Credits)

Principles of atmospheric chemistry; chemical fundamentals, sampling principles, sources, reactions, scavenging, and deposition of sulfur, nitrogen, ozone, and carbon compounds. Atmospheric aerosol size distribution, mechanics, optics, and scavenging. Offered annually.

Recommended: (CH 121 or CH 201 or CH 221 or CH 231 or CH 231H or CH 224) and (MTH 251 or MTH 241)

ATS 417. WEATHER SYSTEM DYNAMICS AND FORECASTING. (4 Credits)

Dynamics of weather systems and basic forecasting methods. Mid-latitude storm formation and structure; basic dynamical equations and applications to real-time weather; map analysis; description and interpretation of weather prediction models; forecasting methods; Pacific NW weather. Lec/Lab.

Prerequisites: ATS 310 with C- or better or ME 311 with C- or better or ME 311H with C- or better or BEE 311 with C- or better or CE 311 with C- or better

ATS 420. PRINCIPLES OF CLIMATE: PHYSICS OF CLIMATE AND CLIMATE CHANGE. (4 Credits)

Physics of climate past, present and future. Covers radiative processes, thermodynamics, and dynamics, as well as the paleoclimate record and mechanisms driving this variability. Current modes of climate variability (e.g., ENSO) will also be surveyed. Climate models, ranging from 0- to 3-dimensional, will be examined and projections for the future assessed.

Recommended: MTH 252 and (PH 202 or PH 202H or PH 212 or PH 212H)

ATS 421. CLIMATE MODELING. (4 Credits)

Numerical models of the physics, chemistry, biology, and geology of the climate system. A range of climate models from a simple, single equation to complex state-of-the-science systems used for future projections. Theoretical concepts will be linked to practical applications through hands-on programming exercises and data analysis. Lec/lab.

Recommended: ATS 420 or ATS 520

ATS 475. PLANETARY ATMOSPHERES. (3 Credits)

Origin and evolution of planetary atmospheres; vertical structure of atmospheres; hazes and clouds; atmospheric motions and general circulation. Presentation of recent observations and current research issues, focusing on Venus, Earth, Mars, Jupiter, Saturn, and Titan. Emphasis on comparative aspects and simple models.

Prerequisites: (MTH 254 with D- or better or MTH 254H with D- or better) and PH 213 [D-]

ATS 499. SPECIAL TOPICS. (0-4 Credits)

This course is repeatable for 12 credits.

ATS 501. RESEARCH. (1-16 Credits)

This course is repeatable for 24 credits.

ATS 503. THESIS. (1-16 Credits)

This course is repeatable for 999 credits.

ATS 505. READING AND CONFERENCE. (1-16 Credits)

This course is repeatable for 16 credits.

ATS 506. PROJECTS. (1-16 Credits)

This course is repeatable for 72 credits.

ATS 507. SEMINAR. (1 Credit)

One-credit sections. Graded P/N.

This course is repeatable for 48 credits.

ATS 508. WORKSHOP. (0-12 Credits)

May be repeated when topic varies.

This course is repeatable for 12 credits.

ATS 511. THERMODYNAMICS AND CLOUD MICROPHYSICS. (4 Credits)

Thermodynamic processes in the atmosphere, and an introduction to cloud microphysics. Offered annually.

Recommended: MTH 254 and PH 213

ATS 512. ATMOSPHERIC RADIATION. (3 Credits)

Radiative transfer in the earth and planetary atmospheres, absorption and scattering of sunlight, radiation, absorption and emission of terrestrial absorption and scattering cross sections for molecules, cloud droplets and aerosols. Applications include enhancement of photochemical reaction rates in clouds, remote sensing, and the earth's radiation budget, radiative-convective equilibrium, radiative forcing due to changes in atmospheric composition and climate change.

Recommended: MTH 254 and MTH 256 and PH 213

ATS 513. ATMOSPHERIC CHEMISTRY. (3 Credits)

Principles of atmospheric chemistry; chemical fundamentals, sampling principles, sources, reactions, scavenging, and deposition of sulfur, nitrogen, ozone, and carbon compounds. Atmospheric aerosol size distribution, mechanics, optics, and scavenging. Offered annually.

Recommended: (CH 121 or CH 201 or CH 221 or CH 231 or CH 231H or CH 224) and (MTH 251 or MTH 241)

ATS 515. ATMOSPHERIC DYNAMICS I. (4 Credits)

Derivation of equations governing atmospheric motions; shallow atmosphere approximation and the primitive equations. Simple balanced flows; vertical motion, circulation, vorticity and potential vorticity; Ekman layer dynamics; prototypical atmospheric waves; geostrophic adjustment; quasi-geostrophic motions; analysis of structure of synoptic-scale systems; baroclinic instability. Offered alternate years.

Recommended: MTH 256 and PH 213

ATS 516. ATMOSPHERIC DYNAMICS II. (4 Credits)

Review of basic equations; scale analysis and approximations. Turbulence and boundary layers. Dry and moist convection; convective storms. Frontogenesis; symmetric instability; internal gravity waves and mountain waves; differentially heated circulations including sea breezes. Slope flows and urban circulations. Offered alternate years.

Prerequisites: ATS 515 with C or better

ATS 517. WEATHER SYSTEM DYNAMICS AND FORECASTING. (4 Credits)

Dynamics of weather systems and basic forecasting methods. Mid-latitude storm formation and structure; basic dynamical equations and applications to real-time weather; map analysis; description and interpretation of weather prediction models; forecasting methods; Pacific NW weather. Lec/Lab.

Prerequisites: OEAS 530 with C- or better

ATS 520. PRINCIPLES OF CLIMATE: PHYSICS OF CLIMATE AND CLIMATE CHANGE. (4 Credits)

Physics of climate past, present and future. Covers radiative processes, thermodynamics, and dynamics, as well as the paleoclimate record and mechanisms driving this variability. Current models of climate variability (e.g., ENSO) will also be surveyed. Climate models, ranging from 0- to 3-dimensional, will be examined and projections for the future assessed.

Recommended: MTH 252 and (PH 202 or PH 202H or PH 212 or PH 212H)

ATS 521. CLIMATE MODELING. (4 Credits)

Numerical models of the physics, chemistry, biology, and geology of the climate system. A range of climate models from a simple, single equation to complex state-of-the-science systems used for future projections. Theoretical concepts will be linked to practical applications through hands-on programming exercises and data analysis. Lec/lab.

Recommended: ATS 420 or ATS 520

ATS 546. EXPERIMENTAL ENERGY AND GAS EXCHANGE. (4 Credits)

Experimental methods to quantify the atmospheric carbon dioxide, water, methane, heat, momentum, and radiative exchange at the vegetation-land-ocean-air interface. Techniques include bulk and gradient approaches, and eddy covariance. The central activity consists of student teams designing and conducting a field experiment, analyzing and interpreting observations, and presenting results. Lec/lab/discussion/activity.

Recommended: (ATS 516 or ATS 564 or FS 564 or ATS 516) and basic programming skills in Matlab or IDL

ATS 564. INTERACTIONS OF VEGETATION AND ATMOSPHERE. (3 Credits)

Quantitative treatment of radiation, heat, mass, and momentum exchange between vegetation and atmosphere; forest, natural and agricultural ecosystem examples. Physical and biological controls of carbon dioxide and water vapor exchange; remote sensing of canopy processes; models of stand-scale evaporation, photosynthesis and respiration; landscape and regional scale exchanges; vegetation and planetary boundary layer coupling; vegetation in global climate models.

Recommended: MTH 251 and PH 201

ATS 575. PLANETARY ATMOSPHERES. (3 Credits)

Origin and evolution of planetary atmospheres; vertical structure of atmospheres; hazes and clouds; atmospheric motions and general circulation. Presentation of recent observations and current research issues, focusing on Venus, Earth, Mars, Jupiter, Saturn, and Titan. Emphasis on comparative aspects and simple models.

Recommended: MTH 254 and PH 213

ATS 590. SPECIAL TOPICS. (0-4 Credits)

May be repeated when topic varies.

This course is repeatable for 12 credits.

ATS 601. RESEARCH. (1-16 Credits)

This course is repeatable for 36 credits.

ATS 603. THESIS. (1-16 Credits)

This course is repeatable for 999 credits.

ATS 605. READING AND CONFERENCE. (1-16 Credits)

This course is repeatable for 16 credits.

ATS 606. PROJECTS. (1-16 Credits)

This course is repeatable for 84 credits.

ATS 607. SEMINAR. (1 Credit)

One-credit sections. Graded P/N.

This course is repeatable for 48 credits.

ATS 608. WORKSHOP. (0-12 Credits)

May be repeated when topic varies.

This course is repeatable for 12 credits.

ATS 615. LARGE-SCALE INTERACTIONS OF THE OCEAN AND ATMOSPHERE. (3 Credits)

Ocean-atmosphere circulations in the time-mean and seasonal cycles, equatorial wave modes, El Nino-Southern Oscillation, Madden-Julian oscillation, teleconnections and atmospheric bridges, mid-latitude air-sea interactions, Pacific and Atlantic decadal variability, the North Atlantic oscillation/Arctic oscillation.

Prerequisites: (ATS 515 with C or better or OC 670 with C or better)

ATS 690. SELECTED TOPICS. (0-4 Credits)

May be repeated for credit when topic varies.

This course is repeatable for 12 credits.

Environmental Sciences

ENSC 101. ENVIRONMENTAL SCIENCES ORIENTATION. (1 Credit)

Introduction to the Environmental Sciences Program and related professional and educational opportunities. Recommended for all freshman and first-year transfer environmental sciences majors, but open to all students interested in learning about career options in the environmental sciences. Graded P/N.

ENSC 399. SPECIAL TOPICS. (1-16 Credits)

This course is repeatable for 16 credits.

ENSC 401. RESEARCH AND SCHOLARSHIP. (1-16 Credits)

This course is repeatable for 24 credits.

ENSC 402. INDEPENDENT STUDIES. (1-16 Credits)

This course is repeatable for 24 credits.

ENSC 403. THESIS. (1-16 Credits)

This course is repeatable for 24 credits.

ENSC 405. READING AND CONFERENCE. (1-12 Credits)

This course is repeatable for 16 credits.

ENSC 406. PROJECTS. (1-16 Credits)

This course is repeatable for 24 credits.

ENSC 407. SEMINAR. (1-16 Credits)

Equivalent to: ENSC 407H

This course is repeatable for 12 credits.

ENSC 407H. SEMINAR. (1-16 Credits)

Attributes: HNRS – Honors Course Designator

Equivalent to: ENSC 407

This course is repeatable for 12 credits.

ENSC 408. WORKSHOP. (1-16 Credits)

This course is repeatable for 12 credits.

ENSC 410. ENVIRONMENTAL SCIENCE INTERNSHIP. (1-12 Credits)

Supervised practical experience working with professionals at selected cooperating institutions, agencies, laboratories, or companies. Graded P/N.

This course is repeatable for 48 credits.

ENSC 479. *^ENVIRONMENTAL CASE STUDIES. (3 Credits)

Improves students' ability to ask questions, gather and synthesize information, and communicate ideas on environmental topics. Instruction and information necessary for the course is entirely Web based. (Bacc Core Course) (Writing Intensive Course)

Attributes: CSST – Core, Synthesis, Science/Technology/Society; CWIC – Core, Skills, WIC

Recommended: One year of college biology or chemistry

ENSC 499. SPECIAL TOPICS. (1-16 Credits)

This course is repeatable for 16 credits.

ENSC 501. RESEARCH AND SCHOLARSHIP. (1-16 Credits)

This course is repeatable for 16 credits.

ENSC 503. THESIS. (1-16 Credits)

PREREQ: Departmental approval required.

This course is repeatable for 999 credits.

ENSC 505. READING AND CONFERENCE. (1-16 Credits)

This course is repeatable for 16 credits.

ENSC 506. PROJECTS. (1-16 Credits)

This course is repeatable for 16 credits.

ENSC 507. SEMINAR. (1-16 Credits)

This course is repeatable for 16 credits.

ENSC 508. WORKSHOP. (1-16 Credits)

PREREQ: Departmental approval required.

This course is repeatable for 16 credits.

ENSC 510. INTERNSHIP. (1-12 Credits)

This course is repeatable for 12 credits.

ENSC 515. ENVIRONMENTAL PERSPECTIVES AND METHODS. (3 Credits)

Unique perspective or method each quarter. Possibilities include: remote sensing, modeling over a range of scales in time, space, and levels of system organization; and risk analysis.

ENSC 520. ENVIRONMENTAL ANALYSIS. (3 Credits)

Develop analytical thinking, explore analytical approaches, enhance writing skills, and gain experience in oral communication about environmental issues.

ENSC 541. ENVIRONMENTAL SCIENCE, SCIENTISTS, AND SOUND DECISIONS. (4 Credits)

Focusing on analyzing the role of environmental science and scientists in decision-making in a variety of professional contexts at various scales (local through global) using a case-study approach and proposing a draft model process.

ENSC 542. MANAGEMENT OPPORTUNITIES IN THE NITROGEN CASCADE. (4 Credits)

Analyzes the environmental science behind reducing excess reactive nitrogen entering the environment through our provision of food, power, and transportation for future populations. Identifies emerging complementary suites of interventions and legislation innovating management practices at local, regional, national and international scales.

ENSC 543. EXCELLING IN AN INTERDISCIPLINARY TEAM. (4 Credits)

Identifying, examining and practicing the top skills, attributes and leadership dynamics involved in working in interdisciplinary environmental science teams in industry, government, and research organizations, informed by experienced experts across these areas.

ENSC 555X. FOOD FOR CHANGE. (3 Credits)

Focusing on traditional regional recipes, explore and document how global change has affected food production and demand until today and how projected climate change will affect it in the future by analyzing the ingredient lists. Focus on one recipe/ingredient, find maps of past/current crop ranges, document changes, and identify possible replacement ingredients projecting future culinary solutions.

Recommended: GEOG 472

ENSC 599. SELECTED TOPICS. (1-16 Credits)

This course is repeatable for 16 credits.

ENSC 601. RESEARCH AND SCHOLARSHIP. (1-16 Credits)

This course is repeatable for 16 credits.

ENSC 603. THESIS. (1-16 Credits)

This course is repeatable for 999 credits.

ENSC 605. READING AND CONFERENCE. (1-16 Credits)

This course is repeatable for 16 credits.

ENSC 606. PROJECTS. (1-16 Credits)

This course is repeatable for 16 credits.

ENSC 607. SEMINAR. (1-16 Credits)

This course is repeatable for 16 credits.

ENSC 699. SELECTED TOPICS. (1-16 Credits)

This course is repeatable for 16 credits.

Geosciences

GEO 100. *NATURAL DISASTERS: HOLLYWOOD VERSUS REALITY. (4 Credits)

Introduction to natural hazards, as seen through the lens of popular media. Course will explore the causes and consequences of natural disasters via in-class exercises and activities designed to develop students' skills in scientific analysis and problem solving. (Bacc Core Course)

Attributes: CPPS – Core, Pers, Physical Science

GEO 101. *THE SOLID EARTH. (4 Credits)

Solid earth processes and materials. Earthquakes, volcanoes, earth structure, rocks, minerals, ores. Solid earth hazard prediction and planning. Geologic time. Lec/lab. (Bacc Core Course)

Attributes: CPPS – Core, Pers, Physical Science

GEO 199. SPECIAL STUDIES. (1-16 Credits)

This course is repeatable for 16 credits.

GEO 201. *PHYSICAL GEOLOGY. (4 Credits)

Study of earth's interior. Tectonic processes and their influence on mountains, volcanoes, earthquakes, minerals, and rocks. Field trip(s) required; transportation fee charged. Lec/lab. (Bacc Core Course)

Attributes: CPPS – Core, Pers, Physical Science

GEO 202. *EARTH SYSTEMS SCIENCE. (4 Credits)

Surficial processes (glaciers, rivers), climate, soils, vegetation, and their interrelationships. Field trip(s) required; transportation fee charged. Lec/lab. (Bacc Core Course)

Attributes: CPPS – Core, Pers, Physical Science

GEO 203. *EVOLUTION OF PLANET EARTH. (4 Credits)

History of earth and life as interpreted from fossils and the rock record. Field trip(s) required; transportation fee charged. Lec/lab. (Bacc Core Course)

Attributes: CPPS – Core, Pers, Physical Science

GEO 221. *ENVIRONMENTAL GEOLOGY. (4 Credits)

Introductory geology emphasizing geologic hazards (volcanoes, earthquakes, landslides, flooding), geologic resources (water, soil, air, mineral, energy), and associated environmental problems and mitigation strategies. Lec/lab. (Bacc Core Course)

Attributes: CPPS – Core, Pers, Physical Science

GEO 295. INTRODUCTION TO FIELD GEOLOGY. (3 Credits)

Two-week course taught in the fall program in various locations throughout the west. Collect field data to make geological maps, cross-sections, columns, and reports. Serves as an introduction to upper-level course work for Geology degree. Lec/lab.

Prerequisites: GEO 201 with C- or better

GEO 305. *LIVING WITH ACTIVE CASCADE VOLCANOES. (3 Credits)

The impact of volcanic activity on people, infrastructure, and natural resources; how and why volcanic activity in the Cascade Range occurs; volcano monitoring and hazard assessment. Field trip required, transportation fee charged. (Bacc Core Course)

Attributes: CSST – Core, Synthesis, Science/Technology/Society

GEO 306. *MINERALS, ENERGY, WATER, AND THE ENVIRONMENT. (3 Credits)

Geologic occurrences, environmental consequences, and future of non-renewable earth resources, including metals, materials, oil, soil, and groundwater. (Bacc Core Course)

Attributes: CSST – Core, Synthesis, Science/Technology/Society

GEO 307. *NATIONAL PARK GEOLOGY AND PRESERVATION. (3 Credits)

National parks as classrooms to study geological processes and the importance of preserving natural landscapes. Field trip(s) required; transportation fee charged. (Bacc Core Course)

Attributes: CSST – Core, Synthesis, Science/Technology/Society

Equivalent to: GEO 307H

GEO 307H. *NATIONAL PARK GEOLOGY AND PRESERVATION. (3 Credits)

National parks as classrooms to study geological processes and the importance of preserving natural landscapes. Field trip(s) required; transportation fee charged. (Bacc Core Course)

Attributes: CSST – Core, Synthesis, Science/Technology/Society; HNRS – Honors Course Designator

Equivalent to: GEO 307

GEO 308. *GLOBAL CHANGE AND EARTH SCIENCES. (3 Credits)

Study of global change over different time scales during the history of the earth, with emphasis on evolution of its atmosphere, plate tectonics, paleoclimates, and mass extinctions. (Bacc Core Course)

Attributes: CSGI – Core, Synth, Global Issues

GEO 309. *ENVIRONMENTAL JUSTICE. (3 Credits)

Technical and social issues surrounding the unequal exposure to environmental hazards based on race and the environmental justice movement that has grown to address charges of such environmental racism. (Bacc Core Course)

Attributes: CPDP – Core, Perspective, Difference/Power/Discrimination

Prerequisites: WR 121 with C- or better or WR 121H with C- or better

Recommended: Sophomore standing

GEO 310. EARTH MATERIALS I: MINERALOGY. (4 Credits)

Principles of crystal morphology, and structure. Characteristics, identification, and origins of minerals. Lec/lab.

Prerequisites: (GEO 201 with D- or better or GEO 221 with D- or better) and ((CH 121 with D- or better or (CH 231 with D- or better and CH 261 [D-]) or (CH 231H [D-] and CH 261H [D-]))

GEO 315. EARTH MATERIALS II: PETROLOGY. (4 Credits)

Origin, identification and classification of igneous, sedimentary, and metamorphic rocks. Field trip(s) required, transportation fee charged. Lec/lab.

Prerequisites: GEO 310 with D- or better

GEO 322. SURFACE PROCESSES. (4 Credits)

Examination of surficial processes and terrestrial landforms of the earth, including slopes, rivers, glaciers, deserts, and coastlines. Field trip(s) required; transportation fee charged. Lec/lab.

Prerequisites: (GEO 102 with D- or better or GEO 102H with D- or better or GEO 202 with D- or better) and (MTH 251 [C-] or MTH 251H [C-]) and (PH 201 [D-] or PH 201H [D-] or PH 211 [D-] or PH 211H [D-])

GEO 340. STRUCTURAL GEOLOGY. (4 Credits)

Analysis of geometry and kinematics of geologic structures including brittle and ductile faults, folds, joints, deformation fabrics. Field trip(s) required; transportation fee charged. Lec/lab.

Prerequisites: GEO 201 with D- or better

GEO 352. *OREGON: GEOLOGY, PLACE, AND LIFE ON THE RING OF FIRE. (4 Credits)

Provides an overview of the geology of Oregon in the context of the Pacific Northwest including tectonic setting, geologic features and landscapes, as well as topics and concepts of interest to society in general. Lessons will include discussion of the relationship between people and the landscape, incorporating the concept of ethnographic landscapes–geologic structures, natural resources and geologic hazards that are part of the identity of a place. Emphasizes written and graphic communication skills. Field trip required, transportation fee charged. Lec/lab. (Bacc core course)

Attributes: CSST – Core, Synthesis, Science/Technology/Society

Equivalent to: GEO 352H

Recommended: Introductory science course

GEO 352H. *OREGON: GEOLOGY, PLACE, AND LIFE ON THE RING OF FIRE. (4 Credits)

Provides an overview of the geology of Oregon in the context of the Pacific Northwest including tectonic setting, geologic features and landscapes, as well as topics and concepts of interest to society in general. Lessons will include discussion of the relationship between people and the landscape, incorporating the concept of ethnographic landscapes–geologic structures, natural resources and geologic hazards that are part of the identity of a place. Emphasizes written and graphic communication skills. Field trip required, transportation fee charged. Lec/lab. (Bacc core course)

Attributes: CSST – Core, Synthesis, Science/Technology/Society; HNRS – Honors Course Designator

Equivalent to: GEO 352

Recommended: Introductory science course

GEO 370. STRATIGRAPHY AND SEDIMENTOLOGY. (4 Credits)

Basic principles of sedimentology and stratigraphy. Sedimentology is largely concerned with classifying and interpreting the origin of sedimentary rocks. Stratigraphy provides formal rules and strategies for organizing sedimentary (and other) rocks into a temporal framework. Reconstruction of Earth history with various approaches centered on paleoclimatology, paleogeography, paleoceanography, and tectonics. Lec/lab.

Prerequisites: GEO 201 with C- or better and GEO 203 [C-]

GEO 380. *EARTHQUAKES IN THE PACIFIC NORTHWEST. (3 Credits)

Earthquake hazards in the Northwest; responses to reducing earthquake risk at state, local, and personal levels. (Bacc Core Course)

Attributes: CSST – Core, Synthesis, Science/Technology/Society

GEO 399. SPECIAL TOPICS. (1-16 Credits)

Equivalent to: GEO 399H

This course is repeatable for 16 credits.

GEO 399H. SPECIAL TOPICS. (1-16 Credits)

Attributes: HNRS – Honors Course Designator

Equivalent to: GEO 399

This course is repeatable for 16 credits.

GEO 400. FIELD TRIPS. (1-16 Credits)

Participation in group field trips that are not a part of any other course. Transportation fee is charged. Students may prepare guides for trips. Faculty sponsor must be prearranged. Graded P/N.

This course is repeatable for 48 credits.

GEO 401. RESEARCH. (1-16 Credits)

Independent, original research subjects guided by faculty conferences and resulting in a brief written report. Faculty sponsor must be prearranged.

This course is repeatable for 24 credits.

GEO 403. THESIS. (1-16 Credits)

Independent, original study that culminates in a senior thesis. Faculty sponsor must be prearranged.

This course is repeatable for 24 credits.

GEO 405. READING AND CONFERENCE. (1-16 Credits)

Independent reading in specialized topics guided by and discussed in faculty conferences. Faculty sponsor must be prearranged.

This course is repeatable for 16 credits.

GEO 407. SEMINAR. (1-16 Credits)

Graded P/N.

This course is repeatable for 12 credits.

GEO 408. WORKSHOP. (1-16 Credits)

This course is repeatable for 12 credits.

GEO 410. INTERNSHIP. (1-15 Credits)

Pre-career professional experience under joint faculty and employer supervision. Graded P/N.

This course is repeatable for 48 credits.

Recommended: 12 credits of upper-division geosciences

GEO 412. IGNEOUS PETROLOGY. (4 Credits)

Petrogenesis of igneous rocks. Petrographic analysis using polarizing microscopes. Field trip may be required, transportation fee charged. Lec/lab.

Prerequisites: GEO 315 with D- or better

Recommended: GEO 415

GEO 415. EARTH MATERIALS III: PETROGRAPHY. (4 Credits)

Microscope-based study of minerals and igneous, sedimentary and metamorphic rocks. Representation and interpretation of geological processes based on microscopic observation. Lec/lab.

Prerequisites: GEO 201 with D- or better and GEO 310 [D-] and GEO 315 [D-]

GEO 427. ^VOLCANOLOGY. (4 Credits)

A survey of volcanoes: their distribution, forms, composition, eruptive products, eruptive styles, and associated phenomena. Field trip may be required; transportation fee charged. Offered alternate years. Lec/lab. (Writing Intensive Course)

Attributes: CWIC – Core, Skills, WIC

Prerequisites: GEO 315 with D- or better

GEO 430. GEOCHEMISTRY. (4 Credits)

Principles of geochemistry applied to problems of earth science. Field trip(s) may be required; transportation fees charged. Lec/rec.

Prerequisites: GEO 315 (may be taken concurrently) with D- or better and ((CH 121 with D- or better and CH 122 [D-]) or ((CH 231 [D-] or CH 231H [D-]) and (CH 261 [D-] or CH 261H [D-]) and (CH 232 [D-] or CH 232H [D-]) and (CH 262 [D-] or CH 262H [D-])))

GEO 431. ENVIRONMENTAL GEOCHEMISTRY. (3 Credits)

An introduction to natural processes at and near the earth's surface, as well as an examination of the impact of human activities on the natural environment. Study includes discussion of the sources, transformations, transport, and fate of contaminants. Field trip(s) required; transportation fee charge.

Prerequisites: (CH 121 with D- or better and CH 122 [D-] and CH 123 [D-]) or ((CH 231 [D-] or CH 231H [D-]) and (CH 232 [D-] or CH 232H [D-]) and (CH 233 [D-] or CH 233H [D-]))

GEO 432. APPLIED GEOMORPHOLOGY. (3 Credits)

Effect of landform processes upon human activity; consequences of resource management strategies on erosional balance within landscape; identification of mitigation of natural hazards; role of geomorphic process studies in environmental planning. Taught as seminar, themes TBA. Field trip(s) may be required; transportation fee charged.

Recommended: GEO 322

GEO 433. COASTAL GEOMORPHOLOGY. (3 Credits)

Morphodynamic approach to coastal landforms, processes and evolution including the impacts and response of humans to coastal change.

Prerequisites: (PH 211 with D- or better or PH 211H with D- or better) and (PH 212 [D-] or PH 212H [D-]) and GEO 322 [D-]

Recommended: MTH 251 and MTH 252

GEO 440. ECONOMIC GEOLOGY. (4 Credits)

Principles of the origin, distribution, and importance of metallic mineral deposits formed by magmatic, hydrothermal, and sedimentary processes. Lec/lab.

Prerequisites: GEO 315 with D- or better

Recommended: GEO 340

GEO 461. GEOLOGY OF EARTHQUAKES. (3 Credits)

Tectonics of the present day as based on surface geology, geodesy, seismicity, and crustal structure; description of active faults and folds; use of neotectonics in evaluation of earthquake hazard. Field trip(s) may be required; transportation fee charged. Offered alternate years.

Prerequisites: GEO 340 with D- or better

GEO 463. ^GEOPHYSICS AND TECTONICS. (4 Credits)

Geophysical observations as constraints on geologic interpretation. Lec/lab. (Writing Intensive Course)

Attributes: CWIC – Core, Skills, WIC

Recommended: MTH 251 and (PH 202 or PH 212)

GEO 481. GLACIAL GEOLOGY. (4 Credits)

Mass balance of glaciers, physics of glacial flow, processes of glacial erosion and deposition, glacial meltwater, glacial isostasy and eustasy, and Quaternary stratigraphy. Field trip(s) may be required; transportation fee charged. Lec/lab. Offered alternate years.

Recommended: GEO 202

GEO 484. INTRODUCTION TO BIOGEOCHEMISTRY. (3 Credits)

Interdisciplinary course, applying concepts from chemistry, physics, biology and geology to Earth systems including terrestrial, ocean and freshwater environments; water and energy cycles; carbon, nitrogen, phosphorus and sulfur cycles; biogeochemical cycles through Earth history.

Prerequisites: MTH 111 with D- or better and ((CH 121 with D- or better and CH 122 [D-]) or (CH 231 [D-] and CH 261 [D-] and CH 232 [D-] and CH 262 [D-]))

GEO 486. QUATERNARY PALEOCLIMATOLOGY. (3 Credits)

Introduction to geochronology, climate proxies, climate forcing, and climate modeling applied to paleoclimate problems. Emphasis on Quaternary climate history.

Prerequisites: (GEO 202 with D- or better or GEO 203 with D- or better) and (CH 122 [D-] or CH 222 [D-] or ((CH 232 [D-] or CH 232H [D-]) and (CH 262 [D-] or CH 262H [D-] or CH 272 [D-])))

Recommended: PH 201 or PH 211

GEO 487. HYDROGEOLOGY. (4 Credits)

Movement of water through porous media. Darcy's Law and groundwater flow equation. Development of groundwater resources. Computer models. Lec/lab.

Prerequisites: MTH 252 with D- or better or MTH 252H with D- or better

Recommended: GEO 202

GEO 488. QUATERNARY STRATIGRAPHY OF NORTH AMERICA. (3 Credits)

Stratigraphic principles applied to Quaternary deposits. Survey Quaternary dating methods. Proxy records of glaciation and climate change. Quaternary stratigraphy of North America, emphasizing stratigraphic records of ice sheets, glaciers, and pluvial lakes. Offered alternate years.

Recommended: GEO 481 or GEO 581

GEO 495. ADVANCED FIELD GEOLOGY. (6 Credits)

Six-week summer program in central Oregon. Collect field data to make geological maps, cross-sections, columns, and reports. Fee charged.

Prerequisites: GEO 295 with C- or better and GEO 315 [C-] and GEO 340 [C-] and GEO 370 [C-]

GEO 497. FIELD MAPPING OF ORE DEPOSITS. (3 Credits)

Eight-day field trip over spring vacation to a mineral district in the western United States, emphasizing detailed mapping of outcrops, trenches, and underground workings. Students prepare final maps and a report suitable for presentation to management or publication during spring term. Transportation fee charged. Not offered every year.

Recommended: (GEO 440 or GEO 540) and GEO 495

GEO 499. SPECIAL TOPICS. (0-16 Credits)

This course is repeatable for 16 credits.

GEO 500. FIELD TRIPS. (1-16 Credits)

Participation in group field trips that are not a part of any other course. Transportation fee is charged. Students may prepare guides for trips. Faculty sponsor must be prearranged. Graded P/N.

This course is repeatable for 48 credits.

GEO 501. RESEARCH. (1-16 Credits)

Independent, original research subjects guided by faculty conferences and resulting in a brief written report. Faculty sponsor must be prearranged.

This course is repeatable for 24 credits.

GEO 503. THESIS. (1-16 Credits)

Independent, original study that culminates in a senior thesis. Faculty sponsor must be prearranged.

This course is repeatable for 999 credits.

GEO 505. READING AND CONFERENCE. (1-16 Credits)

Independent reading in specialized topics guided by and discussed in faculty conferences. Faculty sponsor must be prearranged.

This course is repeatable for 16 credits.

GEO 507. SEMINAR. (1-16 Credits)

Graded P/N.

This course is repeatable for 48 credits.

GEO 508. WORKSHOP. (1-16 Credits)

This course is repeatable for 24 credits.

GEO 510. INTERNSHIP. (1-15 Credits)

Pre-career professional experience under joint faculty and employer supervision. May not be used to meet minimum credit hour requirements for graduate degrees in geosciences. Graded P/N.

This course is repeatable for 16 credits.

Recommended: 12 credits of upper-division geosciences.

GEO 512. IGNEOUS PETROLOGY. (4 Credits)

Petrogenesis of igneous rocks. Petrographic analysis using polarizing microscopes. Field trip may be required, transportation fee charged. Lec/lab.

Recommended: GEO 315 and GEO 415

GEO 516. INTERPRETATION OF GEOLOGIC MAPS. (3 Credits)

Development of skills in formulating geologic problems, using geologic maps, and developing solutions by the scientific method.

Recommended: GEO 495

GEO 518. GEOSCIENCE COMMUNICATION. (3 Credits)

Professional development of the skills of technical editing and writing for geoscientists. Practice the craft of presentation development and delivery, and the broader issues of problem development, and manuscript and proposal writing specific to geoscience graduate students.

GEO 527. VOLCANOLOGY. (4 Credits)

A survey of volcanoes: their distribution, forms, composition, eruptive products, eruptive styles, and associated phenomena. Field trip may be required; transportation fee charged. Offered alternate years. Lec/lab.

Recommended: GEO 315

GEO 530. GEOCHEMISTRY. (4 Credits)

Principles of geochemistry applied to problems of earth science. Field trip(s) may be required; transportation fees charged. Lec/rec.

Recommended: GEO 315 and ((CH 121 and CH 122) or ((CH 231 or CH 231H) and (CH 261 or CH 261H) and (CH 232 or CH 232H) and (CH 262 or CH 262H)))

GEO 531. ENVIRONMENTAL GEOCHEMISTRY. (3 Credits)

An introduction to natural processes at and near the earth's surface, as well as an examination of the impact of human activities on the natural environment. Study includes discussion of the sources, transformations, transport, and fate of contaminants. Field trip(s) required; transportation fee charged.

Recommended: (CH 121 and CH 122 and CH 123) or ((CH 231 or CH 231H) and (CH 232 or CH 232H) and (CH 233 or CH 233H))

GEO 532. APPLIED GEOMORPHOLOGY. (3 Credits)

Effect of landform processes upon human activity; consequences of resource management strategies on erosional balance within landscape; identification of mitigation of natural hazards; role of geomorphic process studies in environmental planning. Taught as seminar, themes TBA. Field trip(s) may be required; transportation fee charged.

Equivalent to: GEOG 549

Recommended: GEO 322

GEO 533. COASTAL GEOMORPHOLOGY. (3 Credits)

Morphodynamic approach to coastal landforms, processes and evolution including the impacts and response of humans to coastal change.

Recommended: MTH 251 and MTH 252 and PH 211 and PH 212 and GEO 322

GEO 535. GEOCHEMICAL ANALYSIS TECHNIQUES. (3 Credits)

An introduction to the theory, techniques and instrumentation used for the chemical analysis of earth materials, with emphasis on analysis of solid earth material samples (predominantly, but not restricted to, rocks). Includes discussions of laboratory safety, relevant statistical approaches, basic physical and chemical principles of analysis, sample preparation techniques and data processing and reporting. Course also includes a large component of hands-on experience with instrumentation available in-house in the College of Earth, Ocean, and Atmospheric Sciences. Lec/lab.

Prerequisites: GEO 530 with C or better

GEO 536. STRUCTURAL AND NEOTECTONIC FIELD METHODS. (3 Credits)

Field-intensive mapping experience emphasizing a topical issue in active tectonics, neotectonics, earthquake geology, or structural geology. One-week field trip required; transportation fee charged. Weekly discussions during quarter. Offered alternate years.

Recommended: GEO 495

GEO 537. TECTONIC GEOMORPHOLOGY. (3 Credits)

Exploration of linkages between patterns of erosion, crustal deformation, and landscape evolution from geomorphic, geologic, geophysical, and modeling perspectives. Field trip required; transportation fee charged. Offered alternate years.

Recommended: GEO 322 and GEO 340

GEO 540. ECONOMIC GEOLOGY. (4 Credits)

Principles of the origin, distribution, and importance of metallic mineral deposits formed by magmatic, hydrothermal, and sedimentary processes. Lec/lab.

Recommended: GEO 315 and GEO 340

GEO 550. COASTAL HAZARDS: PROCESSES, RESPONSE, AND ADAPTATION. (3 Credits)

Coastal hazards and the associated risks they pose to rapidly expanding coastal communities. Examination of coastal hazards from a trans-disciplinary perspective including the physical processes, the coastal response, and coastal adaptation/management options for dealing with the hazards. Emphasizes probabilistic and other user-inspired approaches for assessing coastal vulnerability to the various hazards.

Recommended: College-level calculus, physics and geology

GEO 561. GEOLOGY OF EARTHQUAKES. (3 Credits)

Tectonics of the present day as based on surface geology, geodesy, seismicity, and crustal structure; description of active faults and folds; use of neotectonics in evaluation of earthquake hazard. Field trip(s) may be required; transportation fee charged. Offered alternate years.

Recommended: GEO 340

GEO 563. GEOPHYSICS AND TECTONICS. (4 Credits)

Geophysical observations as constraints on geologic interpretation. Lec/lab.

Recommended: MTH 251 and (PH 202 or PH 212)

GEO 581. GLACIAL GEOLOGY. (4 Credits)

Mass balance of glaciers, physics of glacial flow, processes of glacial erosion and deposition, glacial meltwater, glacial isostasy and eustasy, and Quaternary stratigraphy. Field trip(s) may be required; transportation fee charged. Lec/lab. Offered alternate years.

Recommended: GEO 202

GEO 586. QUATERNARY PALEOCLIMATOLOGY. (3 Credits)

Introduction to geochronology, climate proxies, climate forcing, and climate modeling applied to paleoclimate problems. Emphasis on Quaternary climate history.

Recommended: ((GEO 202 or GEO 203) and (CH 122 or CH 222 or (CH 232 and CH 262) or (CH 232H and CH 262H))) and (PH 201 or PH 211)

GEO 588. QUATERNARY STRATIGRAPHY OF NORTH AMERICA. (3 Credits)

Stratigraphic principles applied to Quaternary deposits. Survey Quaternary dating methods. Proxy records of glaciation and climate change. Quaternary stratigraphy of North America, emphasizing stratigraphic records of ice sheets, glaciers, and pluvial lakes. Offered alternate years.

Recommended: GEO 481 or GEO 581

GEO 597. FIELD MAPPING OF ORE DEPOSITS. (3 Credits)

Eight-day field trip over spring vacation to a mineral district in the western United States, emphasizing detailed mapping of outcrops, trenches, and underground workings. Students prepare final maps and a report suitable for presentation to management or publication during spring term. Transportation fee charged. Not offered every year.

Recommended: (GEO 440 or GEO 540) and GEO 495

GEO 599. SPECIAL TOPICS. (0-16 Credits)

This course is repeatable for 24 credits.

GEO 600. FIELD TRIPS. (1-16 Credits)

Participation in group field trips that are not part of any other course. Transportation fee charged. Students may prepare guide for trips. Faculty sponsors must be arranged. Graded P/N.

This course is repeatable for 84 credits.

GEO 601. RESEARCH. (1-16 Credits)

This course is repeatable for 36 credits.

GEO 603. THESIS. (1-16 Credits)

This course is repeatable for 999 credits.

GEO 605. READING AND CONFERENCE. (1-16 Credits)

This course is repeatable for 16 credits.

GEO 606. PROJECTS. (1-16 Credits)

This course is repeatable for 84 credits.

GEO 607. SEMINAR. (1-16 Credits)

Graded P/N.

This course is repeatable for 48 credits.

GEO 608. WORKSHOP. (1-16 Credits)

This course is repeatable for 24 credits.

GEO 622. IGNEOUS PETROLOGY. (3 Credits)

Controls on the distribution of major and trace elements; theory, applications, and examples. Field trip(s) may be required; transportation fee charged. Offered alternate years.

Recommended: GEO 412 or GEO 512

GEO 633. GEOCHRONOLOGY AND ISOTOPE GEOLOGY. (3 Credits)

Measurements of cosmic and geologic time by radioactive decay. Use of radiogenic and stable isotopic tracers in geology. Offered alternate years.

GEO 666. STABLE ISOTOPE GEOCHEMISTRY. (3 Credits)

Study of the principles governing terrestrial stable isotope distributions, with application to geologic, oceanographic, atmospheric and planetary processes. The primary focus is on isotopes of the light elements such as oxygen, hydrogen, carbon and sulfur, but may include other isotope systems, including Sr/Nd isotopes as geochemical tracers, noble gases, and metal isotopes (eg. Mo, Cu, Fe).

GEO 684. GLOBAL BIOGEOCHEMICAL CYCLES. (4 Credits)

An in-depth treatment of global biogeochemical cycles, focusing on cycles of carbon, oxygen, nitrogen, phosphorus, and sulfur in the atmosphere, hydrosphere, and lithosphere. CROSSLISTED as SOIL 684.

Equivalent to: SOIL 684

Recommended: One year of college-level physics and chemistry, including introductory biology. One year of graduate course work in soil, earth, ocean, atmospheric, or forest science

GEO 691. MASS AND HEAT TRANSPORT IN THE ENVIRONMENT. (4 Credits)

Quantitative treatment of processes affecting transport in lakes, streams, and groundwater: advection; diffusion; dispersion. Lec/lab. Offered alternate years.

Recommended: (GEO 487 or CE 412) or equivalent and MTH 256

GEO 694. TOPICS IN ORE GENESIS. (1-3 Credits)

In-depth examination of published research on selected mineral deposits to build an understanding of environments and processes of ore formation. Offered alternate years.

This course is repeatable for 6 credits.

GEO 699. SPECIAL TOPICS. (1-16 Credits)

This course is repeatable for 24 credits.

Geography

GEOG 100. *CLIMATE JUSTICE. (3 Credits)

Unequal distribution of social, economic and political power that creates winners and losers from climate change. Case studies of climate-change-related environmental degradation, conflict, conservation, climate denial, renewable energy, and investment. Concepts and actions to promote climate justice. Lec/rec. (Bacc Core Course)

Attributes: CPDP – Core, Perspective, Difference/Power/Discrimination

GEOG 102. *PHYSICAL GEOGRAPHY. (4 Credits)

Processes that shape the earth's surface. Weathering, mass movement, landforms, river systems, groundwater, biogeography, human effects on the landscape. Use of maps and imagery. (Bacc Core Course)

Attributes: CPPS – Core, Pers, Physical Science

GEOG 103. *HUMAN GEOGRAPHY. (3 Credits)

Introduction to how human activity affects or is influenced by the earth's surface, including languages, religions, migration, development, and resources. (Bacc Core Course)

Attributes: CPSI – Core, Pers, Soc Proc & Inst

GEOG 105. *GEOGRAPHY OF THE NON-WESTERN WORLD. (3 Credits)

An introduction to the rich variety of environments, population and settlement dynamics, cultures, geopolitical changes, and economies in Africa, the Middle East, and Asia. Lec/lab/rec. (Bacc Core Course)
Equivalent course is GEO 105.

Attributes: CPCD – Core, Pers, Cult Diversity

GEOG 106. *GEOGRAPHY OF THE WESTERN WORLD. (3 Credits)

An introduction to the rich variety of environments, population and settlement dynamics, cultures, geopolitical changes, and economies in Europe and Russia, Australia and Oceania, and the Americas. Lec/rec. (SS) (Bacc Core Course) Equivalent course is GEO 106.

Attributes: CPWC – Core, Pers, West Culture; LACS – Liberal Arts Social Core

GEOG 199. SPECIAL STUDIES. (1-16 Credits)

This course is repeatable for 16 credits.

GEOG 201. *FOUNDATIONS OF GEOSPATIAL SCIENCE AND GIS. (4 Credits)

Basic physical science principles underlying geospatial technologies such as GPS, mobile devices, and online mapping and navigation tools used in GIS, remote sensing, and geovisualization. Concepts and applications in government, business, and the environment. (Bacc Core Course) Equivalent course is GEO 301.

Attributes: CPPS – Core, Pers, Physical Science

GEOG 203. *HUMAN-ENVIRONMENT GEOGRAPHY. (3 Credits)

How human societies manage resources, physical limits to sustainability, role of science in the use and management of resources, and how societal resource use adversely affects other societies, in human history and across spatial scales. Lec/rec. (Bacc Core Course)

Attributes: CPDP – Core, Perspective, Difference/Power/Discrimination

GEOG 240. *CLIMATE CHANGE, WATER AND SOCIETY. (3 Credits)

Introduction to social, ecological and economic impacts of climate change induced water problems in various geographic regions and cultures. Approaches to climate change mitigation and adaptation in various parts of the world. (Bacc Core Course) Equivalent course is GEO 204.

Attributes: CPSI – Core, Pers, Soc Proc & Inst

GEOG 250. *LAND USE PLANNING FOR SUSTAINABLE COMMUNITIES. (3 Credits)

Overview of the history and current practices of land use and community planning. Use basic geospatial tools to assess land use patterns and planning processes. (Bacc Core Course)

Attributes: CPSI – Core, Pers, Soc Proc & Inst

GEOG 251. *GEOGRAPHY OF DISASTER MANAGEMENT. (3 Credits)

Introduction to the geographic concepts and processes for effective disaster management, including response, recovery, mitigation and preparedness. Risk assessment and evidence-based best practices to prepare and respond to emergencies in a variety of geographic contexts. (Bacc Core Course) Equivalent course is GEO 205.

Attributes: CPSI – Core, Pers, Soc Proc & Inst

GEOG 295. INTRODUCTION TO GEOGRAPHIC FIELD RESEARCH. (3 Credits)

Two-week course taught in the fall program in various locations throughout the west. Collect and analyze data associated with both human and physical geography. Field trip required, transportation fee charged. Lec/lab. Equivalent course is GEO 296.

GEOG 299. SPECIAL STUDIES. (1-16 Credits)

This course is repeatable for 16 credits.

GEOG 300. *SUSTAINABILITY FOR THE COMMON GOOD. (3 Credits)

Geography of human relationships to the earth's systems with an emphasis on individual impacts and collective efforts to achieve environmental sustainability. Lec/rec. (SS) (Bacc Core Course)

Attributes: CSGI – Core, Synth, Global Issues; CSST – Core, Synthesis, Science/Technology/Society; LACS – Liberal Arts Social Core

GEOG 311. *GEOGRAPHY OF AFRICA. (3 Credits)

An introduction to the physical, historical, cultural, political, and development geography of Africa south of the Sahara. (NC) (Bacc Core Course) Equivalent course is GEO 325.

Attributes: CPCD – Core, Pers, Cult Diversity; LACN – Liberal Arts Non-Western Core

GEOG 313. *GEOGRAPHY OF ASIA. (3 Credits)

Geographic analysis of Asia's lands and peoples. Emphasis on regional physical environments, resources and development potentials, population trends, and international importance to the United States. Offered once every other year. (NC) (Bacc Core Course) Equivalent course is GEO 327.

Attributes: CPCD – Core, Pers, Cult Diversity; LACN – Liberal Arts Non-Western Core

GEOG 314. *GEOGRAPHY OF LATIN AMERICA. (3 Credits)

Focuses on the diverse landscapes, peoples and cultural traditions of Latin America, a vast region extending from the United States-Mexican border to the southern tip of South America. (NC) (Bacc Core Course)

Attributes: CPCD – Core, Pers, Cult Diversity; LACN – Liberal Arts Non-Western Core

GEOG 323. ^CLIMATOLOGY. (4 Credits)

Systematic analysis of global and regional climates. Physical principles of climate, climate classifications, and distribution and characteristics of climate regimes. Lec/lab. (Writing Intensive Course)

Attributes: CWIC – Core, Skills, WIC

Prerequisites: GEOG 102 with D- or better or GEO 202 with D- or better or GEO 102 with D- or better

GEOG 324. GEOGRAPHY OF LIFE: SPECIES DISTRIBUTIONS AND CONSERVATION. (4 Credits)

Plant, animal, and biotic community distribution and dynamics. Effect of climate, tectonics, disturbance on extinction, speciation, and succession. Field trip(s) required; transportation fee charged. Lec/lab. Equivalent course is GEO 324.

GEOG 330. *^GEOGRAPHY OF INTERNATIONAL DEVELOPMENT AND GLOBALIZATION. (3 Credits)

Introduction to the geography of global wealth and inequality with a focus on contemporary development, underdevelopment, and globalization problems in Asian, African, Caribbean, Latin American, and Pacific Island countries. (Bacc Core Course) (Writing Intensive Course) Equivalent course is GEO 330.

Attributes: CSGI – Core, Synth, Global Issues; CWIC – Core, Skills, WIC

Prerequisites: GEOG 105 with D- or better or GEOG 106 with D- or better or GEO 105 with D- or better or GEO 106 with D- or better

GEOG 331. *POPULATION, CONSUMPTION, AND ENVIRONMENT. (3 Credits)

An examination of population patterns and trends, emphasizing historical growth and more recent demographic changes; using geographic tools to understand patterns of spatial distribution, to use and analyze data sources, and to gain experience interpreting and displaying data about population structure and dynamics; and developing the ability to evaluate the relationship between population, consumption, resources, and quality of life. Patterns of consumption, as individuals and societies will be examined and different future scenarios will be examined with reference to environmental, social and economic sustainability. (Bacc Core Course) Equivalent course is GEO 350.

Attributes: CSGI – Core, Synth, Global Issues

GEOG 340. *INTRODUCTION TO WATER SCIENCE AND POLICY. (3 Credits)

Policy and science of the hydrologic cycle. Emphasis on interaction between water's natural time-space fluctuations and human uses. (Bacc Core Course) Equivalent course is GEO 335 and SOIL 335.

Attributes: CSST – Core, Synthesis, Science/Technology/Society

Equivalent to: GEOG 340H

GEOG 340H. *INTRODUCTION TO WATER SCIENCE AND POLICY. (3 Credits)

Policy and science of the hydrologic cycle. Emphasis on interaction between water's natural time-space fluctuations and human uses. (Bacc Core Course)

Attributes: CSST – Core, Synthesis, Science/Technology/Society; HNRS – Honors Course Designator

Equivalent to: GEOG 340

GEOG 350. *GEOGRAPHY OF NATURAL HAZARDS. (3 Credits)

Introduction to the geography of risk, natural hazards, and disasters, focusing on concepts of vulnerability, adaptation and resilience of human society in the Pacific Northwest and globally. Equivalent course is GEO 304.

Attributes: CSGI – Core, Synth, Global Issues

GEOG 360. GISCIENCE I: GEOGRAPHIC INFORMATION SYSTEMS AND THEORY. (4 Credits)

Fundamentals of spatial data, geographic information systems (GIS), and introductory spatial analysis, programming, and modeling. Equivalent course is GEO 365 and GEO 465.

GEOG 361. GISCIENCE II: ANALYSIS AND APPLICATIONS. (4 Credits)

Applications-based course. Development and conduct of geospatial analyses using various spatial data structures, techniques and models. Students acquire, clean, integrate, manipulate, visualize and analyze geospatial data through laboratory work. Lec/lab. Equivalent course is GEO 480.

Prerequisites: GEOG 360 with C- or better and MTH 112 [C-] and (ST 201 [C-] or ST 351 [C-])

GEOG 370. GEOVISUALIZATION: CARTOGRAPHY. (4 Credits)

Basic cartographic principles. Design, compilation, and construction of maps. Equivalent course is GEO 360.

Prerequisites: GEOG 201 with D- or better or GEO 301 with D- or better

GEOG 371. GEOVISUALIZATION: WEB MAPPING. (4 Credits)

Current developments in Internet mapping and advanced cartographic skills applied to web-based maps. Techniques of Internet mapping and principles of web-based cartography, including multimedia, animation, 3D visualization, and user interface design. Lec/lab.

Prerequisites: GEOG 201 with D- or better or GEO 301 with D- or better

GEOG 399. SPECIAL STUDIES. (1-16 Credits)

Equivalent to: GEOG 399H

This course is repeatable for 16 credits.

GEOG 399H. SPECIAL STUDIES. (1-16 Credits)

Attributes: HNRS – Honors Course Designator

Equivalent to: GEOG 399

This course is repeatable for 16 credits.

GEOG 400. FIELD TRIPS. (1-16 Credits)

Participation in group field trips that are not a part of any other course. Transportation fee is charged. Students may prepare guides for trips.

Faculty sponsor must be prearranged.

This course is repeatable for 48 credits.

GEOG 401. RESEARCH. (1-16 Credits)

Independent, original research subjects guided by faculty conferences and resulting in a brief written report. Faculty sponsor must be prearranged.

This course is repeatable for 24 credits.

GEOG 403. THESIS. (1-16 Credits)

Independent, original study that culminates in a senior thesis. Faculty sponsor must be prearranged.

This course is repeatable for 24 credits.

GEOG 405. READING AND CONFERENCE. (1-16 Credits)

Independent reading in specialized topics guided by and discussed in faculty conferences. Faculty sponsor must be prearranged.

This course is repeatable for 16 credits.

GEOG 407. SEMINAR. (1-16 Credits)

Graded P/N.

This course is repeatable for 16 credits.

GEOG 408. WORKSHOP. (1-16 Credits)

This course is repeatable for 16 credits.

GEOG 410. INTERNSHIP. (1-16 Credits)

Pre-career professional experience under joint faculty and employer supervision. Graded P/N.

This course is repeatable for 16 credits.

Recommended: 12 credits of upper-division geography

GEOG 423. SNOW HYDROLOGY. (3 Credits)

Fundamentals of snow hydrology. Physical principles of snow formation, snowpack accumulation, energy balance, snowcover-climate interactions, snow metamorphism, snowpack ablation, snowpack/snowmelt chemistry, remote sensing of snow, avalanches, field methods, snowmelt/runoff modeling techniques, and watershed processes. Equivalent course is GEO 483.

GEOG 424. HYDROLOGY FOR WATER RESOURCES MANAGEMENT. (3 Credits)

A quantitative introduction to surface and subsurface hydrology with a focus on decision making for the water resource professional.

Prerequisites: MTH 251 with C- or better

GEOG 430. RESILIENCE-BASED NATURAL RESOURCE MANAGEMENT. (3 Credits)

Causes and consequences of conflict over natural resource management at local to global scales; principles for managing social-ecological systems for resilience. Field trip(s) may be required; transportation fee charged. Equivalent course is GEO 420.

GEOG 431. GLOBAL RESOURCES AND DEVELOPMENT. (3 Credits)

Examines resource development issues and strategies in the Global South. Issues and strategies from agriculture, forestry, fisheries, energy, wildlife management, mineral development, land use, and health are examined. Equivalent course is GEO 426.

GEOG 432. *GEOGRAPHY OF FOOD AND AGRICULTURE. (3 Credits)

Overview of food and agriculture in relation to production and consumption regions as a basis for distinguishing different types of food and agricultural systems. Local and global examination of the geographic aspects of breeding, location in agricultural systems, and adaptation in agro-ecosystems using field study, explorations of literature, and lecture. Field trip required, transportation fee charged. (Bacc Core Course) Equivalent course is GEO 449.

Attributes: CSST – Core, Synthesis, Science/Technology/Society

GEOG 440. WATER RESOURCES MANAGEMENT IN THE UNITED STATES. (3 Credits)

An investigation of the various approaches to water resources geography within the U.S. Explores the disciplines that address water resources management, their tools, and their limitations. Topics include engineering, law, economics, risk assessment, game theory, conflict resolution, and the fine arts. Equivalent course is GEO 425.

Recommended: 9 credits of upper-division geography and any course dealing with the hydrologic cycle.

GEOG 441. INTERNATIONAL WATER RESOURCES MANAGEMENT. (3 Credits)

An investigation of the various approaches to water resources geography at the international level. Explores the interaction between water science and policy through issues of current "hydropolitics" and water resources development. Topics include water quality, dams and development, conflict and cooperation, climate change, and water institutions. Equivalent course is GEO 424.

Recommended: 9 credits of upper-division geography and any course dealing with the hydrologic cycle.

GEOG 450. LAND USE IN THE AMERICAN WEST. (3 Credits)

Development of a conceptual framework for land use study; analysis of land as a resource, land use trends, land use principles, and management issues as related to planning, focusing on the American West, the fastest growing region in the nation. Equivalent course is GEO 423.

GEOG 451. PLANNING PRINCIPLES AND PRACTICES FOR RESILIENT COMMUNITIES. (4 Credits)

Applies GIS skills and techniques to determine and analyze future land uses. Determine suitable land uses that incorporate community goals, site constraints and minimize use conflicts. Regulatory and market-based implementation strategies for land uses will also be discussed. Lec/lab. Equivalent course is GEO 452.

Prerequisites: GEOG 360 with C- or better or GEOG 560 with C- or better or GEO 365 with C- or better or GEO 465 with C- or better

GEOG 452. SUSTAINABLE SITE PLANNING. (3 Credits)

Use of geographic concepts and techniques in site planning to create sustainable management reports for local sites. Inventory of environmental characteristics and human uses, conceptual design for future uses of the site, principles of green infrastructure and sustainable building practices. Local field trip required, transportation fee charged. Equivalent course is GEO 451.

Recommended: GEOG 250

GEOG 462. GISCIENCE III: PROGRAMMING FOR GEOSPATIAL ANALYSIS. (4 Credits)

Introduction to the extension of geographic information systems (GIS) through programming. No prior programming experience is expected. Teaches a pragmatic approach to design and write programs for geospatial analysis. Equivalent course is GEO 578.

Prerequisites: GEOG 361 with C- or better or GEOG 561 with C- or better or GEO 480 with C- or better

GEOG 463. GISCIENCE IV: SPATIAL MODELING. (4 Credits)

Introduction to spatial simulation models representing attraction, segregation, individual entities, and processes of spread, applied to contemporary problems in human and physical geography.

Prerequisites: GEOG 462 with C- or better or GEOG 562 with C- or better or GEO 578 with C- or better

GEOG 464. GEOSPATIAL PERSPECTIVES ON INTELLIGENCE, SECURITY, AND ETHICS. (3 Credits)

Applications and implications of geospatial science (GIS, remote sensing, and spatial analysis) in intelligence, human, environmental, and ethical domains. Concepts and practices of ethics in geospatial science, including data access, management, visualization, and decision-making. Equivalent course is GEO 567.

Prerequisites: GEOG 360 with C- or better or GEOG 560 with C- or better or GEO 365 with C- or better or GEO 465 with C- or better

Recommended: Senior standing

GEOG 472. GEOVISUALIZATION: GEOVISUAL ANALYTICS. (3 Credits)

Concepts and techniques underlying the production of maps by computer. Practical experience with a variety of computer mapping packages. Lec/lab. Equivalent course is GEO 445.

Prerequisites: GEOG 370 with C- or better or GEOG 371 with C- or better or GEO 360 with C- or better

GEOG 480. REMOTE SENSING I: PRINCIPLES AND APPLICATIONS. (4 Credits)

Fundamentals of satellite remote sensing and image analysis. Topics include physical principles of remote sensing from the ultraviolet to the microwave, sensors and sensor technology, and environmental applications of remote sensing through image analysis. Lec/lab. Equivalent course is GEO 444.

Prerequisites: GEOG 201 with C- or better or GEO 301 with C- or better

GEOG 481. REMOTE SENSING II: DIGITAL IMAGE PROCESSING. (4 Credits)

Digital analysis of remote sensor data. Image display enhancement, classification, and rectification principles. Practical experience with an image processing system. Equivalent course is GEO 466.

Prerequisites: (GEOG 480 with C- or better or GEOG 580 with C- or better or GEO 444 with C- or better or GEO 544 with C- or better) and (ST 202 [D-] or ST 352 [D-])

GEOG 495. FIELD GEOGRAPHY OF OREGON I. (3 Credits)

Designed as a capstone experience. Challenges students to assess the origins of the physical features of a landscape, and evaluate the impacts of features on the area's human geography, and vice versa. Three weekend field trips required, transportation fee charged. Equivalent course is GEO 435.

Prerequisites: GEOG 295 with C- or better or GEO 295 with C- or better

Recommended: Junior or senior standing

GEOG 499. SPECIAL STUDIES. (1-16 Credits)

This course is repeatable for 16 credits.

GEOG 500. FIELD TRIPS. (1-16 Credits)

Participation in group field trips that are not a part of any other course. Transportation fee charged. Students may prepare guides for trips. Faculty sponsor must be prearranged.

This course is repeatable for 48 credits.

GEOG 501. RESEARCH. (1-16 Credits)

Independent, original research subjects guided by faculty conferences and resulting in a brief written report. Faculty sponsor must be prearranged.

This course is repeatable for 24 credits.

GEOG 503. THESIS. (1-16 Credits)

Independent, original study that culminates in a thesis. Faculty sponsor must be prearranged.

This course is repeatable for 999 credits.

GEOG 505. READING AND CONFERENCE. (1-16 Credits)

Independent reading in specialized topics guided by and discussed in faculty conferences. Faculty sponsor must be prearranged.

This course is repeatable for 16 credits.

GEOG 507. SEMINAR. (1-16 Credits)

Graded P/N.

This course is repeatable for 16 credits.

GEOG 508. WORKSHOP. (1-16 Credits)

This course is repeatable for 16 credits.

GEOG 510. INTERNSHIP. (1-15 Credits)

Pre-career professional experience under joint faculty and employer supervision. Graded P/N.

This course is repeatable for 16 credits.

GEOG 511. HISTORY AND PHILOSOPHY OF GEOGRAPHY. (3 Credits)

The historical development of research traditions in the discipline of geography. This includes an examination of changes in conceptual structures and current trends. Equivalent course is GEO 515.

GEOG 512. SOCIAL-ECOLOGICAL SYSTEMS. (3 Credits)

Exploration of critical debates surrounding theories associated with social-ecological systems, resilience, vulnerability, adaptation, social learning, transformation, adaptive governance. Equivalent course is GEO 554.

Recommended: 9 credits of graduate study.

GEOG 523. SNOW HYDROLOGY. (3 Credits)

Fundamentals of snow hydrology. Physical principles of snow formation, snowpack accumulation, energy balance, snowcover-climate interactions, snow metamorphism, snowpack ablation, snowpack/snowmelt chemistry, remote sensing of snow, avalanches, field methods, snowmelt/runoff modeling techniques, and watershed processes. Equivalent course is GEO 583.

GEOG 524. HYDROLOGY FOR WATER RESOURCES MANAGEMENT. (3 Credits)

A quantitative introduction to surface and subsurface hydrology with a focus on decision making for the water resource professional.

Recommended: MTH 251

GEOG 530. RESILIENCE-BASED NATURAL RESOURCE MANAGEMENT. (3 Credits)

Causes and consequences of conflict over natural resource management at local to global scales; principles for managing social-ecological systems for resilience. Field trip(s) may be required; transportation fee charged. Equivalent course is GEO 520.

GEOG 531. GLOBAL RESOURCES AND DEVELOPMENT. (3 Credits)

Examines resource development issues and strategies in the Global South. Issues and strategies from agriculture, forestry, fisheries, energy, wildlife management, mineral development, land use, and health are examined. Equivalent course is GEO 526.

GEOG 532. GEOGRAPHY OF FOOD AND AGRICULTURE. (3 Credits)

Overview of food and agriculture in relation to production and consumption regions as a basis for distinguishing different types of food and agricultural systems. Local and global examination of the geographic aspects of breeding, location in agricultural systems, and adaptation in agro-ecosystems using field study, explorations of literature, and lecture. Field trip required, transportation fee charged. Equivalent course is GEO 549.

GEOG 540. WATER RESOURCES MANAGEMENT IN THE UNITED STATES. (3 Credits)

An investigation of the various approaches to water resources geography within the U.S. Explores the disciplines that address water resources management, their tools, and their limitations. Topics include engineering, law, economics, risk assessment, game theory, conflict resolution, and the fine arts. Equivalent course is GEO 525.

Recommended: 9 credits of upper-division geography and any course dealing with the hydrologic cycle.

GEOG 541. INTERNATIONAL WATER RESOURCES MANAGEMENT. (3 Credits)

An investigation of the various approaches to water resources geography at the international level. Explores the interaction between water science and policy through issues of current "hydropolitics" and water resources development. Topics include water quality, dams and development, conflict and cooperation, climate change, and water institutions. Equivalent course is GEO 524.

Recommended: 9 credits of upper-division geography and any course dealing with the hydrologic cycle.

GEOG 546. ADVANCED LANDSCAPE AND SEASCAPE ECOLOGY. (4 Credits)

Pattern-process interactions in large scale ecological and physical systems, including terrestrial, aquatic, and marine/ocean ecosystems. Principles of pattern-process interactions from genetic to community levels of ecological organization applied to design of conservation reserves. Hypothesis testing, field techniques, spatial models/statistics, GIS/remote sensing. Lec/lab. Equivalent course is GEO 546.

GEOG 550. LAND USE IN THE AMERICAN WEST. (3 Credits)

Development of a conceptual framework for land use study; analysis of land as a resource, land use trends, land use principles, and management issues as related to planning, focusing on the American West, the fastest growing region in the nation. Equivalent course is GEO 523.

GEOG 551. PLANNING PRINCIPLES AND PRACTICES FOR RESILIENT COMMUNITIES. (4 Credits)

Applies GIS skills and techniques to determine and analyze future land uses. Determine suitable land uses that incorporate community goals, site constraints and minimize use conflicts. Regulatory and market-based implementation strategies for land uses will also be discussed. Lec/lab. Equivalent course is GEO 552.

Prerequisites: GEOG 360 with C or better or GEOG 560 with C or better

GEOG 552. SUSTAINABLE SITE PLANNING. (3 Credits)

Use of geographic concepts and techniques in site planning to create sustainable management reports for local sites. Inventory of environmental characteristics and human uses, conceptual design for future uses of the site, principles of green infrastructure and sustainable building practices. Local field trip required, transportation fee charged. Equivalent course is GEO 551.

Recommended: GEOG 250

GEOG 560. GISCIENCE I: INTRODUCTION TO GEOGRAPHIC INFORMATION SCIENCE. (4 Credits)

Introduction to modern spatial data processing, development, and functions of geographic information systems (GIS); theory, concepts and applications of geographic information science (GIScience). Equivalent course is GEO 565.

GEOG 561. GISCIENCE II: ANALYSIS AND APPLICATIONS. (4 Credits)

Applications-based course. Development and conduct of geospatial analyses using various spatial data structures, techniques and models. Students acquire, clean, integrate, manipulate, visualize and analyze geospatial data through laboratory work. Lec/lab. Equivalent course is GEO 580.

Prerequisites: GEOG 560 with C or better

GEOG 562. GISCIENCE III: PROGRAMMING FOR GEOSPATIAL ANALYSIS. (4 Credits)

Introduction to the extension of geographic information systems (GIS) through programming. No prior programming experience is expected. Teaches a pragmatic approach to design and write programs for geospatial analysis. Equivalent course is GEO 578.

Prerequisites: GEOG 361 with C or better or GEOG 561 with C or better

GEOG 563. GISCIENCE IV: SPATIAL MODELING. (4 Credits)

Introduction to spatial simulation models representing attraction, segregation, individual entities, and processes of spread, applied to contemporary problems in human and physical geography.

Prerequisites: GEOG 462 with C or better or GEOG 562 with C or better

GEOG 564. GEOSPATIAL PERSPECTIVES ON INTELLIGENCE, SECURITY, AND ETHICS. (3 Credits)

Applications and implications of geospatial science (GIS, remote sensing, and spatial analysis) in intelligence, human, environmental, and ethical domains. Concepts and practices of ethics in geospatial science, including data access, management, visualization, and decision-making. Equivalent course is GEO 567.

Prerequisites: GEOG 360 with C or better or GEOG 560 with C or better

GEOG 565. SPATIO-TEMPORAL VARIATION IN ECOLOGY AND EARTH SCIENCE. (4 Credits)

Objectives and techniques of spatial and temporal analysis. Point patterns, geostatistics, spectral analysis, wavelet analysis, interpolation, and mapping. Equivalent course is GEO 541.

GEOG 566. ADVANCED SPATIAL STATISTICS AND GISCIENCE. (4 Credits)

Provides advanced graduate students from a variety of disciplines in earth science and ecology the opportunity to structure and conduct spatio-temporal analyses using available software tools and their own datasets for their graduate research. Equivalent course is GEO 584.

GEOG 571. GEOVISUALIZATION: WEB MAPPING. (4 Credits)

Overview of methods and applications in interactive, dynamic cartographic visualization. Design and construction of customized user interfaces to geographic information. Lec/lab. Equivalent course is GEO 568.

Recommended: GEOG 370

GEOG 572. GEOVISUALIZATION: GEOVISUAL ANALYTICS. (3 Credits)

Concepts and techniques underlying the production of maps by computer. Practical experience with a variety of computer mapping packages. Lec/lab. Equivalent course is GEO 545.

Recommended: GEOG 370 or GEOG 371

GEOG 580. REMOTE SENSING I: PRINCIPLES AND APPLICATIONS. (4 Credits)

Fundamentals of satellite remote sensing and image analysis. Topics include physical principles of remote sensing from the ultraviolet to the microwave, sensors and sensor technology, and environmental applications of remote sensing through image analysis. Lec/lab. Equivalent course is GEO 544.

Recommended: GEOG 201 or GEO 301

GEOG 581. REMOTE SENSING II: DIGITAL IMAGE PROCESSING. (4 Credits)

Digital analysis of remote sensor data. Image display enhancement, classification, and rectification principles. Practical experience with an image processing system. Equivalent course is GEO 566.

Prerequisites: GEOG 580 with C or better

Recommended: ST 352 or ST 202

GEOG 595. FIELD GEOGRAPHY OF OREGON II. (3 Credits)

Designed to introduce students to the widest possible range of topics on all aspects of Oregon geography within a limited time, then turn that experience into a viable research proposal. While physical processes are the primary topic, resource and environmental effects are stressed. Field trip required, transportation fee charged. Equivalent course is GEO 534.

GEOG 596. FIELD RESEARCH IN GEOMORPHOLOGY AND LANDSCAPE ECOLOGY. (3 Credits)

Natural history interpretation of disturbance and recovery processes and management implications in forest-stream landscapes of western Oregon. Course consists of field experience and several seminars. Transportation and lodging fee charged. Equivalent course is GEO 548.

Recommended: 9 graduate credits in sciences or engineering.

GEOG 599. SPECIAL STUDIES. (1-16 Credits)

This course is repeatable for 24 credits.

GEOG 600. FIELD TRIPS. (1-16 Credits)

Participation in group field trips that are not a part of any other course. Transportation fee charged. Students may prepare guides for trips. Faculty sponsor must be prearranged.

This course is repeatable for 48 credits.

GEOG 601. RESEARCH. (1-16 Credits)

Independent, original research subjects guided by faculty conferences and resulting in a brief written report. Faculty sponsor must be prearranged.

This course is repeatable for 36 credits.

GEOG 603. THESIS. (1-16 Credits)

Independent, original study that culminates in a thesis. Faculty sponsor must be prearranged.

This course is repeatable for 999 credits.

GEOG 605. READING AND CONFERENCE. (1-16 Credits)

Independent reading in specialized topics guided by and discussed in faculty conferences. Faculty sponsor must be prearranged.

This course is repeatable for 16 credits.

GEOG 607. SEMINAR. (1-16 Credits)

Graded P/N.

This course is repeatable for 16 credits.

GEOG 608. WORKSHOP. (1-16 Credits)

This course is repeatable for 16 credits.

GEOG 699. SPECIAL STUDIES. (1-16 Credits)

This course is repeatable for 24 credits.

Geophysics

GPH 501. RESEARCH. (1-16 Credits)

Original research work that will not be part of the data used in a thesis. Graded P/N.

This course is repeatable for 24 credits.

GPH 503. THESIS. (1-16 Credits)

Thesis research and writing.

This course is repeatable for 999 credits.

GPH 505. READING AND CONFERENCE. (1-16 Credits)

Independent reading and library research on specialized topics in geophysics, guided by discussions with supervising faculty. A written report may be required.

This course is repeatable for 16 credits.

GPH 507. SEMINAR. (1-16 Credits)

This course is repeatable for 48 credits.

GPH 601. RESEARCH. (1-16 Credits)

Original research work that will not be part of the data used in a thesis. Graded P/N.

This course is repeatable for 36 credits.

GPH 603. THESIS. (1-16 Credits)

Thesis research and writing.

This course is repeatable for 999 credits.

GPH 605. READING AND CONFERENCE. (1-16 Credits)

Independent reading and library research on specialized topics in geophysics guided by discussions with supervising faculty. A written report may be required.

This course is repeatable for 16 credits.

GPH 607. SEMINAR. (1-16 Credits)

This course is repeatable for 48 credits.

GPH 630. ELEMENTS OF SEISMOLOGY. (4 Credits)

Survey of basic concepts in global seismology: world seismicity; elastic structure of the earth; seismic wave paths in the earth; locating earthquakes; earthquake focal mechanisms, magnitudes, stress drop, energy; stress and strain, elasticity, wave equation, plane waves in homogeneous and layered media, surface waves, free oscillations; ray theory; seismometry; earthquake prediction. Laboratory exercises include interpretation and analysis of seismograms from global seismographic networks.

Recommended: Differential equations.

GPH 632. CRUSTAL SEISMOLOGY. (3 Credits)

Structure of the earth's crust and upper mantle from seismic reflection and large offset (refraction, wide-angle reflection) data. Methods of data collection, data processing theory and practice, modeling and interpretation techniques, correlation of seismic results with laboratory measurements of rock properties, and regional case studies.

Prerequisites: GPH 630 with C or better

GPH 640. GEODESY. (4 Credits)

Physical and observational geodesy, including the Earth's gravity field and potential and determination of the Earth's geoid. Interpretation of geoid, geoid anomalies, and isostatic compensation. Gravity, point-position and remote sensing geodetic measurement techniques, including GPS, InSAR, VLBI, leveling, triangulation/trilateration, and low-Earth orbit gravity satellite missions are covered as are geodetic reference frames. Offered alternate years.

GPH 641. ELECTROMAGNETIC METHODS IN GEOPHYSICS. (3 Credits)

Survey of electromagnetic (EM) methods in geophysics. Review of electromagnetic theory, Maxwell's equations in the quasi-static limit, the diffusion of EM fields in a layered conductor, qualitative discussion of EM fields in 2- and 3-D conductors. EM techniques, including DC resistivity, magnetotellurics, controlled source EM, induced polarization, and long-period magnetometer array methods. Applications to exploration, to basic research on crustal structure and to studies of upper-mantle conductivity.

Recommended: Upper-division EM course.

GPH 642. EARTH MAGNETISM. (3 Credits)

Geomagnetism and magnetic potential: general morphology and secular change; internal and external sources; principles of paleomagnetism, including field and laboratory procedures; origin of remnant magnetism in rocks and the controlling physical and chemical processes; the origin of the Earth's magnetic field.

GPH 650. GEOPHYSICAL INVERSE THEORY. (4 Credits)

Survey of the theory and applications of inverse methods currently used in the geophysical sciences for the interpretation of inaccurate and inadequate data. Backus-Gilbert inverse theory, resolution, regularization methods (such as damped least squares) for linear and non-linear problems, stochastic inversion, and extremal models. Applications to seismic, gravity, magnetic and electromagnetic data.

Recommended: Linear algebra

GPH 651. GEODYNAMICS I. (3 Credits)

Application of the techniques of continuum mechanics to geological problems. Thermal and subsidence history of the lithosphere; stress and strain in the earth; elasticity and flexure of the lithosphere; gravitational compensation. Lec. Offered odd years on Corvallis campus in fall term (subject to change).

GPH 665. GEOPHYSICAL FIELD TECHNIQUES. (3 Credits)

Instrumentation, field methods and interpretation of gravimetric, magnetic, electrical and seismic prospecting techniques. Students will be required to collect, reduce, analyze, and interpret data.

GPH 689. SPECIAL TOPICS IN GEOPHYSICS. (1-4 Credits)

Special topics of current interest in geophysics, not covered in detail in other courses. May be repeated on different topics for credit.

This course is repeatable for 16 credits.

Marine Resource Management

MRM 501. RESEARCH AND SCHOLARSHIP. (1-16 Credits)

Graded P/N.

This course is repeatable for 24 credits.

MRM 503. THESIS. (1-16 Credits)

This course is repeatable for 999 credits.

MRM 505. READING AND CONFERENCE. (1-16 Credits)

This course is repeatable for 16 credits.

MRM 506. PROJECTS. (1-16 Credits)

This course is repeatable for 72 credits.

MRM 507. SEMINAR. (1-16 Credits)

This course is repeatable for 48 credits.

MRM 508. WORKSHOP. (1-16 Credits)

This course is repeatable for 24 credits.

MRM 510. INTERNSHIP. (1-9 Credits)

Planned and supervised resource management experience with selected cooperating governmental agencies, private organizations, or business firms. Supplementary conferences, reports and evaluations. Graded P/N. *This course is repeatable for 16 credits.*

MRM 525. SPECIAL TOPICS IN MARINE RESOURCE MANAGEMENT. (1-4 Credits)

Subjects of current interest in marine resource management not covered in depth in other courses. May be repeated for credit when topic varies.

This course is repeatable for 24 credits.

MRM 530. PRINCIPLES AND PRACTICE OF MARINE RESOURCE MANAGEMENT. (3 Credits)

Introduces learners to the core concepts/skills required for guiding the management of the interactions between human and natural marine systems. Particular attention is given to the concept and framework of Ecosystem-Based Management, the goal of which is to conserve, maintain and restore ecosystem functions to promote the economic and ecological sustainability of marine ecosystems and human communities that depend on the services they provide. Tomorrow's marine resource managers must be capable of identifying, requesting, analyzing, synthesizing, and combining natural and social science with experiential knowledge and human/social capital to generate meaningful policy and management recommendations and strategies.

MRM 534. OCEANS IN CRISIS. (3 Credits)

Explores the state of the world's oceans and coasts, whether or not they are indeed in crisis, and what, if any management responses can be reasonably expected to halt and restore our oceans.

MRM 535. RIGHTS-BASED FISHERIES MANAGEMENT. (3 Credits)

Clear, appropriate and enforceable fishing entitlements and responsibilities are a cornerstone of sustainable fisheries management. Rights-based management tools such as dedicated access privileges, community quotas, co-management and cost recovery will be explored as ways of promoting individual and collective responsibility for sustainable fisheries management. High seas fisheries will also be addressed.

MRM 552. MARINE ECONOMICS. (3 Credits)

Economic aspects of marine resource utilization and management will be analyzed. Topics include open access aspect of marine resources; conflict and allocation of marine resources, marine resource markets, marine recreation, pollution, and aquaculture, with special emphasis on commercial fisheries. CROSSLISTED as AEC 552 .

Equivalent to: AEC 552

Recommended: AEC 351 or AEC 352 or AREC 351 or AREC 352

MRM 599. SPECIAL TOPICS. (1-16 Credits)

This course is repeatable for 24 credits.

Oceanography

OC 103. *EXPLORING THE DEEP. GEOGRAPHY OF THE WORLD'S OCEANS. (4 Credits)

Introduces non-science students to the oceans, including marine geology and chemistry, ocean currents, coastal and biological processes. Field trip required, transportation fee charged. Lec/lab. (Bacc Core Course)

Attributes: CPPS – Core, Pers, Physical Science

OC 199. SPECIAL TOPICS IN OCEANOGRAPHY. (1-4 Credits)

Introduction to topics of current interest in oceanography for lower-division undergraduates. May be repeated for credit when topic varies.

This course is repeatable for 16 credits.

OC 201. *OCEANOGRAPHY. (4 Credits)

Plate tectonics and the geological structure of ocean basins; physical and chemical properties of seawater; Earth's energy budget; large-scale circulation of the atmosphere and ocean; marine sediment properties and transport; Earth history recorded in marine sediments; the carbon cycle in the atmosphere and sea; and the ecology of pelagic and benthic systems. Lec/lab. (Bacc Core Course)

Attributes: CPPS – Core, Pers, Physical Science

OC 295. INTRODUCTION TO FIELD OCEANOGRAPHY. (3 Credits)

One-week course taught during Spring Break at Hatfield Marine Science Center, with ten hours of preparatory meetings on the Corvallis campus. Collect oceanographic data and samples from ships and coastal marine habitats and conduct preliminary analysis of data and samples. Serves as an introduction to upper-division course work in ocean science. Field trip(s) required; transportation fee charged.

Prerequisites: OC 201 with D- or better or OC 332 with D- or better or OC 332H with D- or better

OC 296. INTRODUCTION TO FIELD OCEANOGRAPHY - SEA. (2 Credits)

The sea-going field portion of OC 295 onboard a large research vessel. During the multi-day cruise students will collect oceanographic data and samples from the coastal ocean. Students who complete OC 295 and OC 296 will learn how to collect data and samples on the high seas, conduct preliminary analyses of data, and contribute to the development of scientific knowledge. Serves as an introduction to upper-division course work in oceanography.

Prerequisites: OC 295 with P or better

OC 332. COASTAL OCEANOGRAPHY. (3 Credits)

Physics, geology, biology and hydrology of coastal oceans. How coastal waters respond to forcing by heating, cooling, winds, tides, waves, rain, evaporation, river runoff and freezing. Geography and geology of coastlines: erosion and deposition processes, beach dynamics. Coastal equilibrium cells as sources and sinks of sediment. Rocky shore, beach, mudflat, estuarine, and coastal biotic communities; animal migrations. Law of the Sea rights and responsibilities of coastal states. Fisheries and mariculture in coastal seas. Pollution and coastal ocean resources. Using a matrix to define environmental problems; pathways that pollutants take through the coastal ecosystem. Offered annually.

OC 333. OCEANS, COASTS, AND PEOPLE. (3 Credits)

Contemporary issues related to human interactions with the oceans and coastal zones, including living and energy resources, geohazards and impacts of global change. Content presented in lectures, readings and group discussions, with project oral presentations.

Recommended: OC 201

OC 334. *POLAR OCEANOGRAPHY. (3 Credits)

Explores the physical, chemical and biological oceanography of the Arctic and Antarctic and examines the impacts of man's activities both directly through resource utilization, and indirectly through climate change. Introduction to polar oceanography through a series of lectures, interactive classes, written assignments and a case study. (Writing Intensive Course)

Attributes: CWIC – Core, Skills, WIC

Prerequisites: OC 201 with D- or better

OC 399. SPECIAL TOPICS IN OCEANOGRAPHY. (1-4 Credits)

Equivalent to: OC 399H

This course is repeatable for 16 credits.

OC 399H. SPECIAL TOPICS IN OCEANOGRAPHY. (1-4 Credits)

Attributes: HNRS – Honors Course Designator

Equivalent to: OC 399

This course is repeatable for 16 credits.

OC 401. RESEARCH PROJECTS. (1-16 Credits)

Field and laboratory research in oceanography for undergraduates, resulting in a written report.

This course is repeatable for 24 credits.

OC 403. THESIS. (1-16 Credits)

Independent, original study that culminates in a senior thesis. Faculty sponsor must be prearranged. Graded P/N.

This course is repeatable for 24 credits.

OC 405. READING AND CONFERENCE. (1-4 Credits)

Independent library research and reading in specialized topics in oceanography for undergraduates, guided by discussions in conferences with faculty. A written report may be required.

This course is repeatable for 16 credits.

OC 407. SEMINAR. (1-3 Credits)

Undergraduate seminar on current developments in the oceanographic research literature, with student presentations and group discussions. A written report may be required.

Equivalent to: OC 407H

This course is repeatable for 12 credits.

OC 407H. SEMINAR. (1-3 Credits)

Undergraduate seminar on current developments in the oceanographic research literature, with student presentations and group discussions. A written report may be required.

Attributes: HNRS – Honors Course Designator

Equivalent to: OC 407

This course is repeatable for 12 credits.

OC 410. INTERNSHIP. (1-16 Credits)

Pre-career professional experience under joint faculty and employer supervision. Graded P/N.

This course is repeatable for 48 credits.

Recommended: 12 credits of upper-division college courses

OC 430. PRINCIPLES OF PHYSICAL OCEANOGRAPHY. (4 Credits)

Fundamental principles of physical oceanography; conservation of mass, heat, momentum and vorticity; equations governing motion in the ocean; geostrophy; planetary boundary layers; wind-driven and thermohaline circulation. Descriptive oceanography; application of the fundamental principles to the ocean; examination of the major current systems; water mass analysis. Offered annually.

Recommended: One year each of college physics and college calculus.

OC 433. COASTAL AND ESTUARINE OCEANOGRAPHY. (3 Credits)

Circulation of the coastal ocean including continental shelf circulation, upwelling, coastal jets, undercurrents, coastal-trapped waves.

Fundamentals of surface waves and tides; tsunamis, wind generation, breaking waves. Estuary classification and circulation patterns; shallow-water processes and beach morphology. Offered alternate years.

Recommended: One year of college physics and one year of calculus.

OC 434. ESTUARINE ECOLOGY. (4 Credits)

Integrated and synthetic training in the ecological processes of estuarine environments, with emphases on ecological interactions among organisms and the biogeochemical cycling of carbon and nitrogen.

Topics include geomorphology, estuarine physics and chemistry, primary and secondary producers, ecosystem metabolism, element cycling, food webs, fisheries, restoration management, and impacts of climate. Field trip required, transportation fee charged. CROSSLISTED as FW 434/ FW 534. Offered on Corvallis campus via interactive video from HMSC campus.

Equivalent to: FW 434

OC 440. BIOLOGICAL OCEANOGRAPHY. (4 Credits)

An advanced examination of the ocean as an ecosystem with emphasis on the processes affecting the production and structure of oceanic communities. Starting with the physical and chemical characteristics of the ocean environment, lectures and labs examine the flow of energy and matter from primary producers through primary consumers up to higher trophic levels. Microbial and benthic processes are examined. Current topics, such as hypoxia, ocean acidification and harmful algal blooms are discussed. Lec/lab.

Prerequisites: OC 201 with C- or better

Recommended: Two terms of college-level biology

OC 449. ECOLOGICAL THEORIES IN BIOLOGICAL AND FISHERIES OCEANOGRAPHY DATA. (4 Credits)

Students will learn the ecological theories applied in fisheries oceanography research and analytical techniques used to quantify fisheries oceanography processes. The lecture and lab sessions will be presented in the context of fundamental ecological research, including effects of environmental and climate variability on production and distribution of species and communities. A specific emphasis is toward analyses of large spatio-temporal data. Lec/Lab.

Prerequisites: (MTH 252 with C or better or MTH 252H with C or better or MTH 228 with C or better) and (ST 351 [C] or ST 351H [C]) and (OC 440 (may be taken concurrently) [C] or BI 370 [C] or BI 370H [C])

OC 450. CHEMICAL OCEANOGRAPHY. (4 Credits)

Chemical properties and processes in the oceans. Composition, origin and evolution of sea water; thermodynamic and kinetic predictions for reactions in sea water; major and minor element reservoirs and fluxes; vertical and horizontal transport of materials; isotopic clocks and tracers; nutrients; chemical processes and fluxes across major marine interfaces, including estuaries, atmosphere, sediments, suspended particles and hydrothermal systems. Lec/Lab.

Prerequisites: CH 122 with D- or better or CH 232 with D- or better or CH 232H with D- or better

Recommended: one year of college-level general chemistry.

OC 460. GEOLOGICAL OCEANOGRAPHY. (3 Credits)

Structure of ocean basins, plate tectonics and sea floor spreading, marine sedimentation, history of ocean basins, and analysis of geological and geophysical data. Offered annually.

Recommended: One year each of physics and chemistry or science background.

OC 499. SPECIAL TOPICS IN OCEANOGRAPHY. (0-4 Credits)

Subjects of current interest in oceanography, not covered in depth in other courses. May be repeated for credit when topic varies.

This course is repeatable for 16 credits.

OC 501. RESEARCH. (1-16 Credits)

Original research work that will not be part of the data used in a thesis. Graded P/N.

This course is repeatable for 24 credits.

OC 503. THESIS. (1-16 Credits)

Thesis research and writing.

This course is repeatable for 999 credits.

OC 505. READING AND CONFERENCE. (1-16 Credits)

Independent reading and library research on specialized topics in oceanography, guided by discussions with supervising faculty. A written report may be required.

This course is repeatable for 16 credits.

OC 506. PROJECTS. (1-16 Credits)

This course is repeatable for 72 credits.

OC 507. SEMINAR. (1-3 Credits)

Student presentations and discussions of current research literature or personal research results. Original research presentations by visiting scientists, OSU faculty and graduate students presenting final thesis results. Other sections and specific topics by arrangement.

This course is repeatable for 48 credits.

OC 508. WORKSHOP. (1-16 Credits)

This course is repeatable for 24 credits.

OC 512. BASIC MATLAB FOR ENVIRONMENTAL SCIENTISTS AND ENGINEERS. (2 Credits)

MATLAB desktop environment will be introduced and basic programming and data analysis skills will be developed, with an emphasis on writing optimized routines to analyze data sets utilizing matrix algebra and vectorization of functions. Basic graphics and visualization will be covered, including two-dimensional and three-dimensional graphing, contouring and movies.

OC 515. OREGON COAST MATH CAMP. (3 Credits)

Selected topics from differential calculus, integral calculus, ordinary and partial differential equations, statistics, linear algebra and vector calculus. Two-week course taught at Hatfield Marine Science Center in Newport, Oregon, before fall term begins. Graded P/N.

Recommended: Differential and integral calculus and linear algebra

OC 521. APPLICATIONS IN OCEAN ECOLOGY AND BIOGEOCHEMISTRY. (4 Credits)

Methodological underpinnings of marine ecology and biogeochemistry. Students will learn about both new and traditional methods of seawater analysis and biological rate determinations. They will evaluate methods by analyzing observations and samples, and assessing the interpretive effectiveness of approaches. Lec/lab.

Prerequisites: OEAS 540 with C or better

Corequisites: OC 522, OC 523

OC 522. OCEAN BIOGEOCHEMICAL DYNAMICS. (4 Credits)

Examines what keeps ocean systems in balance, and determines their response to perturbation. The course relies on connections between physical transport and biogeochemical reaction rates and energetics, taught from the perspective of key ocean biogeochemical cycles.

Corequisites: OC 521, OC 523

OC 523. OCEAN ECOLOGICAL DYNAMICS. (4 Credits)

Major characteristics of ocean biota and ocean ecosystems. Main themes will be centered on the bioenergetics of marine systems at levels ranging from the individual to ocean biomes, and on how ocean biota facilitates diverse marine biogeochemical processes. Lec/rec.

OC 528. MICROPROBE ANALYSIS. (3 Credits)

Theory and application of electron microprobe analysis to problems in geology, engineering, chemistry, physics, and biology.

OC 533. COASTAL AND ESTUARINE OCEANOGRAPHY. (3 Credits)

Circulation of the coastal ocean including continental shelf circulation, upwelling, coastal jets, undercurrents, coastal-trapped waves. Fundamentals of surface waves and tides; tsunamis, wind generation, breaking waves; shallow-water processes and beach morphology. Offered alternate years.

Recommended: One year of college physics and one year of calculus.

OC 534. ESTUARINE ECOLOGY. (4 Credits)

Integrated and synthetic training in the ecological processes of estuarine environments, with emphases on ecological interactions among organisms and the biogeochemical cycling of carbon and nitrogen.

Topics include geomorphology, estuarine physics and chemistry, primary and secondary producers, ecosystem metabolism, element cycling, food webs, fisheries, restoration management, and impacts of climate. Field trip required, transportation fee charged. CROSSLISTED as FW 434/ FW 534.

Equivalent to: FW 534

OC 549. ECOLOGICAL THEORIES IN BIOLOGICAL AND FISHERIES OCEANOGRAPHY DATA. (4 Credits)

Students will learn the ecological theories applied in fisheries oceanography research and analytical techniques used to quantify fisheries oceanography processes. The lecture and lab sessions will be presented in the context of fundamental ecological research, including effects of environmental and climate variability on production and distribution of species and communities. A specific emphasis is toward analyses of large spatio-temporal data. Lec/Lab.

Recommended: (MTH 252 or MTH 252H or MTH 228) and (ST 351 or ST 351H) and (OC 440 or BI 370 or BI 370H)

OC 561. IGNEOUS AND TECTONIC PROCESSES IN THE OCEAN. (3 Credits)

An integrated view of the igneous and tectonic processes responsible for the formation and evolution of the ocean basins. The course is organized by tectonic environment including ridge crest, ridge flank, ocean basins, seamounts, and active and passive margins.

Recommended: One year each physics, calculus and geology.

OC 562. SEDIMENTARY PROCESSES IN THE OCEAN BASINS. (3 Credits)

An integrated view of sediment processes in the ocean basins from a source to sink perspective, with a special emphasis on the interpretation of the historical record.

Recommended: OC 550 and one year each physics and calculus and geology.

OC 574. EARLY LIFE HISTORY OF FISHES. (4 Credits)

Overview of diversity of development patterns in fishes; emphasis on morphology, life history, and evolution. Offered alternate years. CROSSLISTED as FW 574.

Equivalent to: FW 574

Recommended: FW 315

OC 599. SPECIAL TOPICS IN OCEANOGRAPHY. (0-4 Credits)

Subjects of current interest in oceanography, not covered in depth in other courses. May be repeated for credit when topic varies. *This course is repeatable for 12 credits.*

OC 601. RESEARCH. (1-16 Credits)

Original research work that will not be part of the data used in a thesis. Graded P/N.

This course is repeatable for 36 credits.

OC 603. THESIS. (1-16 Credits)

Thesis research and writing.

This course is repeatable for 999 credits.

OC 605. READING AND CONFERENCE. (1-16 Credits)

Independent reading and library research on specialized topics in oceanography, guided by discussions with supervising faculty. A written report may be required.

This course is repeatable for 16 credits.

OC 606. PROJECTS. (1-16 Credits)

This course is repeatable for 84 credits.

OC 607. SEMINAR. (1-3 Credits)

Student presentations and discussion of current research literature or personal research results. Original research presentations by visiting scientists, OSU faculty and graduate students presenting final thesis results. Other sections and specific topics by arrangement.

This course is repeatable for 48 credits.

OC 608. WORKSHOP. (1-16 Credits)

This course is repeatable for 24 credits.

OC 630. OCEAN WAVE MECHANICS I. (3 Credits)

Linear wave boundary value problem formulation and solution, water particle kinematics, shoaling, refraction, diffraction, and reflection. Linear long wave theory with applications to tides, seiche, and storm surge. CROSSLISTED as CE 630. Lec/lab.

Equivalent to: CE 630

OC 631. OCEAN WAVE MECHANICS II. (3 Credits)

Second in the sequence of ocean engineering wave mechanics, covers the following topics: introduction to long wave theory, wave superposition, wave height distribution, and the wind-wave spectrum, introduction to wave forces, and basic nonlinear properties of water waves. May include additional selected topic in wave mechanics.

CROSSLISTED as CE 631.

Prerequisites: CE 630 with C or better or OC 630 with C or better

Equivalent to: CE 631

OC 634. LONG WAVE MECHANICS. (3 Credits)

Theory of long waves. Depth-integrated Euler's equation and its jump conditions. Evolution equations and their solutions. Nonlinear shallow-water waves, the Korteweg-deVries equation and Boussinesq equation. Boundary-layer effects. Shallow-water waves on beaches. Applications of the fundamentals to problems of tsunamis. CROSSLISTED as CE 634.

Prerequisites: OC 630 with C or better and CE 631 [C]

Equivalent to: CE 634

Recommended: OC 670

OC 635. APPLIED MODELING OF NEARSHORE PROCESSES. (4 Credits)

An introduction to numerical modeling of the nearshore ocean, providing hands-on experience with state-of-the-art numerical models for wave propagation, nearshore circulation, planform shoreline evolution and bathymetric profile evolution. Focuses on review of model requirements, detailed study of several specific models for several domains of interest, application to coastal phenomena, interpretation of model results. Lec/lab. Offered alternate years. CROSSLISTED as CE 635.

Equivalent to: CE 635

OC 646. PHYSICAL/BIOLOGICAL INTERACTIONS IN THE UPPER OCEAN. (4 Credits)

Variability in physical oceanic processes in the upper ocean and relationship to spatial and temporal variations in biomass, growth rates, and other biological patterns in the organisms of ocean surface waters. The relationship between variability in ocean physical phenomena and ecosystem dynamics, including the requirements of sampling design for upper ocean ecological studies. Time and space scales of physical and biological phenomena in the upper ocean. Offered alternate years. Offered alternate years, typically fall term.

Prerequisites: OEAS 530 with C or better and OEAS 540 [C]

OC 649. SPECIAL TOPICS IN BIOLOGICAL OCEANOGRAPHY. (1-4 Credits)

Special topics of current interest in biological oceanography not covered in detail in other courses. May be repeated for credit when topic varies.

This course is repeatable for 16 credits.

OC 657. SEDIMENT BIOGEOCHEMISTRY. (3 Credits)

An overview of early diagenetic processes in marine sediments and the interdisciplinary approaches used to quantify material transformations at the seafloor.

Recommended: OC 550

OC 659. SPECIAL TOPICS IN CHEMICAL OCEANOGRAPHY. (1-4 Credits)

Special topics of current interest in chemical oceanography not covered in detail by other courses. May be repeated for credit when topic varies.

This course is repeatable for 16 credits.

OC 660. PALEOCEANOGRAPHY. (3 Credits)

Large-scale changes in the oceanic and atmospheric system, as recorded in marine sediments, and their implications for understanding global environment changes. Chemical, physical, and biological proxies for oceanic and atmospheric processes in the geologic record period. Evidence for changing global climate at time scales longer than the historical record; the oceanic history of the Late-Cenozoic ice ages, long term evolution of climate change patterns, catastrophic global environmental events, and application of quantitative models to the past. Current research topics in paleoceanography. Offered alternate years.

Recommended: OC 560

OC 662. NEARSHORE HYDRODYNAMICS. (3 Credits)

Briefly reviews wave processes in the nearshore, and concentrates on the wave-averaged circulation with an eye towards its potential effects on bathymetric change.

Recommended: Previous courses related to water wave mechanics and differential equations

OC 664. NEARSHORE SEDIMENT TRANSPORT. (3 Credits)

To study the dynamics of a nearshore wave field propagating over a shoaling bathymetry, the response of sediments and morphology to those motions, emergent morphology due to the coupled system, anthropogenic influences and mitigation.

Recommended: General physics, integral and differential calculus; nearshore hydrodynamics.

OC 666. ISOTOPIC MARINE GEOCHEMISTRY. (3 Credits)

Radiogenic and light stable isotopes and application to composition and evolution of the suboceanic mantle, petrogenesis of the oceanic crust, sediment provenance and sedimentary processes, geochronology, seawater chemical dynamics and paleoclimatology. Offered alternate years.

OC 668. THEORETICAL PETROLOGY. (3 Credits)

Theoretical aspects of igneous petrology in marine petrochemical processes. Igneous and metamorphic geology; hydrothermal solutions. Principles of energy, enthalpy, entropy. Equilibrium processes of melting, crystallization, mineral chemistry, geothermometers, geobarometers. Offered alternate years.

Recommended: Petrology.

OC 669. SPECIAL TOPICS IN GEOLOGICAL OCEANOGRAPHY. (1-4 Credits)

Subjects of current interest in geological oceanography not covered in depth in other courses. May be repeated for credit when topic varies.

This course is repeatable for 16 credits.

OC 670. FLUID DYNAMICS. (4 Credits)

Fundamentals of fluid dynamics: conservation laws of mass, momentum, and energy; inviscid and viscous flows; boundary layers; vorticity dynamics; irrotational and potential flow. Offered annually.

Recommended: One year of college physics; mathematics through differential equations and vector calculus.

OC 671. GEOPHYSICAL FLUID DYNAMICS. (4 Credits)

Dynamics of rotating and stratified fluids, potential vorticity, geostrophic motion; inviscid shallow-water theory, Poincare, Kelvin, and Rossby waves; geostrophic adjustment, quasigeostrophic approximation, Ekman layers, two-layer and continuously stratified models. Offered annually.

Prerequisites: OC 670 with C or better

OC 672. THEORY OF OCEAN CIRCULATION. (4 Credits)

Theory of steady and time-dependent large-scale circulation in ocean basins. Effects of earth's curvature: the beta-plane approximation. The wind-driven Sverdrup circulation, western boundary currents, eastern boundary upwelling; the effects of friction. Linear theory and nonlinear theory; inertial gyres. Effects of buoyancy forcing; heating, cooling, evaporation, precipitation; density stratification. Wind- and buoyancy-forced circulation in the thermocline; ventilation. Potential vorticity conservation and homogenization. Offered annually.

Prerequisites: OC 670 with C or better and OC 671 [C]

OC 673. DESCRIPTIVE PHYSICAL OCEANOGRAPHY. (4 Credits)

Fundamental mass, force, and energy balances of the ocean; geostrophy; planetary boundary layers; wind-driven and thermohaline circulation; vorticity; air-sea fluxes of heat, salt, moisture and momentum. Application of these balances through descriptive examination of the ocean-global heat budget; surface current systems; abyssal circulation. Study of variability on a variety of time and space scales. Instrumentation and platforms used for observing the ocean. Offered annually.

Prerequisites: OC 530 with C or better or OC 670 with C or better or ATS 515 with C or better

OC 674. TURBULENCE. (4 Credits)

Governing equations, turbulent kinetic energy, vorticity dynamics; turbulent transports of mass and momentum; statistical description of turbulent flows, spectral dynamics; turbulent boundary layers, planetary boundary layers in the atmosphere and ocean, convective mixed layers, stable boundary layers; deep ocean turbulence. Offered alternate years.

Prerequisites: OC 670 with C or better

OC 675. NUMERICAL MODELING IN OCEAN CIRCULATION. (4 Credits)

Review of theoretical models of ocean circulation, including shallow water, barotropic, quasigeostrophic, and primitive equation models; adjustment times, internal length and time scales; the role of advection, bathymetry, and coastlines; global models, basin models, regional models and models of jets, eddies and boundary currents. Review of numerical techniques and problems specific to ocean modeling. Local facilities are used to develop models on remote supercomputers.

Prerequisites: OC 670 with C or better

Recommended: Working knowledge of FORTRAN

OC 676. INVERSE MODELING AND DATA ASSIMILATION. (4 Credits)

Survey of methods for combining oceanographic observations and observing systems with numerical models of ocean circulation. Topics include: finite-dimensional least squares theory with inequality constraints; optimal interpolation; the representation theory of smoothing; the Kalman smoother and filter; gradient descent methods for minimization; spatial and temporal regularity of filters and smoothers; linear theory of array design; nonlinear optimization, practical assimilation methods.

Recommended: Strong background in linear algebra and advanced calculus, geophysical fluid dynamics, numerical modeling of ocean circulation.

OC 678. OCEAN REMOTE SENSING. (4 Credits)

Theory and applications of satellite remote sensing observations of the ocean with emphasis on strengths and limitations in the measurements. Topics include review of electricity and magnetism, absorption and scattering in the atmosphere (radiative transfer), satellite orbital mechanics, measurements of ocean color, infrared remote sensing, microwave radiometry, scatterometry, and satellite altimetry. Offered alternate years.

Recommended: MTH 252 and PH 212

OC 679. SPECIAL TOPICS IN PHYSICAL OCEANOGRAPHY. (1-4 Credits)

Subjects of current interest in physical oceanography, not covered in depth in other courses. May be repeated for credit when topic varies.

This course is repeatable for 16 credits.

OC 680. STABILITY OF GEOPHYSICAL FLUID FLOWS. (4 Credits)

Linear perturbation analysis applied to geophysical flows. These methods provide both quantitative and conceptual insight into the formative stages of turbulent flow. Emphasis is on practical numerical methods for the solution of differential eigenvalue problems. Examples are drawn from a wide range of geophysical flow instabilities, based in part upon student interests.

Prerequisites: OC 670 with C or better

Recommended: Multivariate calculus, matrix calculus, Matlab and concurrent enrollment in OC 670

OC 681. GEOPHYSICAL WAVES. (4 Credits)

Fundamentals of wave dynamics applied to geophysical fluids. Hyperbolic waves—linear and nonlinear; characteristics; shock waves. Dispersive waves—linear waves, dispersion relations, group velocity; isotropic and anisotropic dispersion; nonlinear solitary waves. Application to geophysical waves—surface gravity, capillary, internal gravity, Kelvin, planetary, coastal. Offered alternate years.

Prerequisites: OC 670 with C or better

OC 682. DATA ANALYSIS IN THE TIME AND SPACE DOMAINS. (4 Credits)

Theory of classical and modern techniques for analysis of data in the time and space domains with applications to real oceanographic and atmospheric data. Topics include correlation analysis, regression analysis, EOF analysis, objective mapping, interpolation, filtering, sampling errors, and confidence tests. Offered alternate years.

Recommended: MTH 341 and MTH 342 and MTH 418 and OC 608 and ST 314 and a working knowledge of Matlab, IDL, or FORTRAN

OC 683. DATA ANALYSIS IN THE FREQUENCY AND WAVE NUMBER DOMAINS. (4 Credits)

Theory of classical and modern techniques for analysis of data in the frequency and wavenumber domains with applications to real oceanographic and atmospheric data. Topics include sampling theory, one-dimensional autospectral analysis, multidimensional autospectral analysis, coherence and phase analysis, bi-spectral analysis, wavelet analysis, and confidence tests. Offered alternate years.

Recommended: MTH 341 and MTH 342 and MTH 418 and OC 608 and ST 314 and a working knowledge of Matlab, IDL, or FORTRAN

OC 691. PROPOSAL WRITING. (3 Credits)

Teaches the use of NSF Fastlane. Includes a discussion of ethics and fairness in reviewing, a review of real proposals by faculty, a simulated NSF funding panel, and then development of a real proposal, for review purposes. This will relate directly to the student's current thesis or project. The course enables graduate students from all disciplines to develop rigorous, well thought-out proposals. It should be taken early enough in the program so that the proposal process contributes to their research progress.

OC 808. WORKSHOP. (1-16 Credits)

This course is repeatable for 16 credits.

Ocean, Earth, and Atmospheric Sciences

OEAS 500. CASCADIA FIELD TRIP. (2-4 Credits)

A field course to various locations within the Cascade volcanic arc, Coast Range and Oregon Coast. Introduction to the range of physical and biological science topics to be covered in OEAS 520, OEAS 530 and OEAS 540 in field settings; the linkages between these topics, and their impact on humans, with case examples. Students will practice math skills, and collect samples and data to be used in laboratory sessions in the later courses. Offered annually. Transportation fee charged. Graded P/N.

This course is repeatable for 4 credits.

OEAS 511X. PROFESSIONAL INSTRUCTION IN CEOAS. (1 Credit)

Provides graduate teaching assistants and potential teaching assistants in the College of Earth, Ocean, and Atmospheric Sciences with an introduction to effective instruction techniques, including the expectations of instructors, teaching pedagogy, use of technology, ethical instruction, inclusivity in the classroom and other topics.

OEAS 520. THE SOLID EARTH. (4 Credits)

Movement of mass and energy within the Earth and into/out of its outer surface, expressed as plate tectonics, earthquakes, heat flow, volcanoes, geomagnetic field; composition, structure, hydrology and aging of ocean crust; lithosphere creation, recycling and mantle overturn. Marine sedimentation, sources and transport, continental weathering, tectonics-climate interactions, glacial history and sea level response. Geohazards, storm events, beach and estuary processes. Offered annually. Lec/lab.

Recommended: One year each of physics, chemistry and calculus

OEAS 530. THE FLUID EARTH. (4 Credits)

Fundamental principles of fluid circulation in the atmosphere and ocean. Atmospheric chemistry, radiation, thermodynamics, and dynamics. Conservation of mass, heat, momentum and vorticity in the ocean; equations governing motion; geostrophy; planetary boundary layers; wind-driven and thermohaline circulation. Air-sea fluxes and global circulation models; climate change. Offered annually. Lec/lab.

Recommended: One year each of physics, chemistry, calculus, or science and a field course

OEAS 540. THE BIOGEOCHEMICAL EARTH. (4 Credits)

Integrating fundamental concepts in biological and chemical oceanography to understand energy and material transformations in estuarine, coastal and open ocean habitats. Topics include structure and function of marine ecosystems, biogeochemical cycles, and human impacts. Offered annually. Lec/lab.

Recommended: One year of physics, chemistry, and calculus