College of Earth, Ocean, and Atmospheric Sciences

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College of Earth, Ocean, and Atmospheric Sciences (CEOAS)
The Earth is a complex system shaped by natural and human forces. Oregon State University’s College of Earth, Ocean, and Atmospheric Sciences (CEOAS) is renowned for excellence in basic and applied research on Earth systems. Our work is global, extending from the Pacific Northwest to both poles, from the bottom of the ocean to the upper reaches of the atmosphere, from human interactions with the environment to studies of other planets in our solar system. CEOAS faculty, staff, and students contribute to the success of the global science enterprise by serving as intellectual leaders, innovators, and stewards of critical research infrastructure for Oregon and the nation.

Academic programs in CEOAS are interwoven with research and combine classroom excellence with experiential learning, including extensive field experiences. Novel undergraduate programs in Ocean Science, Climate Science, and Geography and Geospatial Science are paired with highly successful undergraduate programs in Geology and Environmental Sciences. Our graduate programs are recognized as among the best in the world and include interdisciplinary majors Marine Resource Management and Ocean, Earth, and Atmospheric Sciences as well as disciplinary foci in Geology and Geography. All our programs successfully place students in academic, government, nonprofit, and private sector jobs.

Undergraduate Programs
Program Requirements
The University Baccalaureate Core requirements are explained in a separate section, Earning a Degree at Oregon State University (http://catalog.oregonstate.edu/earning-degrees/). 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.

Graduate Programs
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.

**Teaching and Research Faculty**

https://ceoas.oregonstate.edu/faculty

**Advisors**

https://ceoas.oregonstate.edu/undergraduate-advising

**Emeritus**

https://ceoas.oregonstate.edu/emeritus-and-retired-faculty

**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
- Chemistry and the Environment
- 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-ms-phd/)
- Geology (http://catalog.oregonstate.edu/college-departments/earth-ocean-atmospheric-sciences/geology-ms-phd/)
- Marine Resource Management (http://catalog.oregonstate.edu/college-departments/earth-ocean-atmospheric-sciences/marine-resource-management-ma-ms-phantom/)
- Ocean, Earth and Atmospheric Sciences (http://catalog.oregonstate.edu/college-departments/earth-ocean-atmospheric-sciences/ocean-earth-atmospheric-sciences-ma-phantom/)

**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/)
- 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-

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)

ATS 003, UNDERGRADUATE RESEARCH, 0 Credits
Engage in research activities appropriate to the discipline; and through the research experience, acquire skills, techniques, and knowledge relevant to the field of study. In consultation with a faculty mentor, engage in research activity, and make and execute a plan for a project.

ATS 004, INTERNSHIP, 0 Credits
Provides basic personal and professional skills that can be used within and outside of a work setting. Through practice, this experience guides students in building and maintaining positive professional relationships, networking/mentoring relationships, and enhances students’ understanding of the connection between theory and practice in their respective disciplines.

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 Available via Ecampus

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

ATS 302, MATHEMATICAL APPLICATIONS IN THE EARTH SCIENCES, 4 Credits
An introductory survey of mathematical applications in climate science, meteorology, oceanography, geology, and geophysics. Topics may include conservation laws, harmonic motion, exponential growth/decay, linear approximations, numerical methods, waves, diffusion, fluid flow, systems of equations, inverse problems, and data analysis. Prerequisite: MTH 252 with C- or better Recommended: PH 201 or PH 211

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. Prerequisite: (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 341, *SNOW, SMOKE, AND STORMS: CLIMATE CHANGE IMPACTS IN THE PNW, 3 Credits
Climate change will alter mountain snowpack, water availability, coastal storms, erosion, and sea level in the Pacific Northwest. Increasing temperatures and changing precipitation patterns will lead to more extreme drought and flooding events, wildfire seasons, and insect and disease outbreaks in forests. These changes will impact the region's natural resource economy; heritage and quality of life; water, transportation, and energy infrastructure; and health and social systems. Case studies of past extreme years highlight the close interrelationships between the climate, the natural and built environment, and the health and well-being of the Pacific Northwest's residents. Attributes: CSST – Core, Synthesis, Science/Technology/Society

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

ATS 412, ATMOSPHERIC RADIATION, 3 Credits
Examines properties of radiation and the electromagnetic spectrum. Explores reflection and refraction; radiative properties of natural surfaces; thermal emission; atmospheric transmission and emission; absorption by atmospheric gases; broadband fluxes and heating rates; introduction to the radiative transfer equation; scattering and absorption by particles.
Prerequisite: (MTH 254 with C- or better or MTH 254H with C- or better) and (PH 202 [C-] or PH 212 [C-])

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, mechanisms, optics, and scavenging. Offered annually.
Recommended: (CH 121 [D] or CH 201 [D] or CH 231 [D] or CH 231H [D]) and (MTH 251 [D] or MTH 241[D])

ATS 415, ATMOSPHERIC DYNAMICS, 4 Credits
Prerequisite: ATS 301 with C- or better and ATS 310 [C-] and (ATS 302 (may be taken concurrently) [C-] or MTH 254 (may be taken concurrently) [C-]) and (PH 202 (may be taken concurrently) [C-] or PH 212 (may be taken concurrently) [C-])

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.
Prerequisite: 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, CLIMATE PHYSICS, 4 Credits
Prerequisite: (MTH 252 with C- or better or MTH 252H with C- or better) and (PH 202 [C-] or PH 212 [C-]) and (ATS 301 [C-] or (PH 365 [C-] and PH 366 [C-])) and (ATS 310 [C-] or PH 315 [C-])

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.
Prerequisite: ATS 420 with C- or better and (ATS 301 [C-] or (PH 365 [C-] and PH 366 [C-])) and (MTH 254 [C-] or ATS 302 [C-])
ATS 441, NORTHWEST CLIMATE AND WEATHER, 4 Credits
A survey of climate and weather phenomena that are consequential in the northwestern United States. The Pacific Ocean, the North Pacific jet and storm track, mountain and coastal meteorology, and topographic features like the region’s mountains and Columbia River Gorge all affect the climate and weather of the Northwest, which in turn affect the region’s hydrologic characteristics, vegetation, and numerous other natural and human systems. Preexisting content knowledge and analytical skills are used to produce a comprehensive written report and oral presentation for a regional stakeholder. (Writing Intensive Course)
Attributes: CWIC – Core, Skills, WIC
Prerequisite: ATS 301 with C- or better and ATS 420 [C-]

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

ATS 499, SPECIAL TOPICS, 0-4 Credits
Equivalent to: ATS 499H
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
Examines properties of radiation and the electromagnetic spectrum. Explores reflection and refraction; radiative properties of natural surfaces; thermal emission; atmospheric transmission and emission; absorption by atmospheric gases; broadband fluxes and heating rates; introduction to the radiative transfer equation; scattering and absorption by particles.

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, 4 Credits
Prerequisite: OEAS 530 with C- or better
Recommended: One year of college calculus and physics

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.
Prerequisite: 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.
Prerequisite: OEAS 530 with C- or better

ATS 520, CLIMATE PHYSICS, 4 Credits
Prerequisite: OEAS 530 with C- or better
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.
Prerequisite: ATS 520 with C- or better or OEAS 530 with C- or better
Recommended: One year of college calculus and physics. Python programming experience or concurrent enrollment in ATS 508 (Python for Climate Modeling)

ATS 541, NORTHWEST CLIMATE AND WEATHER, 4 Credits
A survey of climate and weather phenomena that are consequential in the northwestern United States. The Pacific Ocean, the North Pacific jet and storm track, mountain and coastal meteorology, and topographic features like the region's mountains and Columbia River Gorge all affect the climate and weather of the Northwest, which in turn affect the region's hydrologic characteristics, vegetation, and numerous other natural and human systems. Preexisting content knowledge and analytical skills are used to produce a comprehensive written report and oral presentation for a regional stakeholder.
Prerequisite: OEAS 530 with C- or better or ATS 520 with C- or better

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 [D-] or ATS 564 [D-] or FS 564 [D-]

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.
Equivalent to: FS 564
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 599, SPECIAL TOPICS, 0-4 Credits
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 99 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.
Prerequisite: (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.

ATS 699, SPECIAL TOPICS, 0-4 Credits
This course is repeatable for 12 credits.

Environmental Sciences (ENSC)
ENSC 003, UNDERGRADUATE RESEARCH, 0 Credits
Engage in research activities appropriate to the discipline; and through the research experience, acquire skills, techniques, and knowledge relevant to the field of study. In consultation with a faculty mentor, engage in research activity, and make and execute a plan for a project.

ENSC 004, INTERNSHIP, 0 Credits
Provides basic personal and professional skills that can be used within and outside of a work setting. Through practice, this experience guides students in building and maintaining positive professional relationships, networking/mentoring relationships, and enhances students’ understanding of the connection between theory and practice in their respective disciplines.
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 299, SPECIAL TOPICS, 1-16 Credits
This course is repeatable for 16 credits.

ENSC 399, SPECIAL TOPICS, 1-16 Credits
Equivalent to: ENSC 399H
This course is repeatable for 16 credits.

ENSC 401, RESEARCH AND SCHOLARSHIP, 1-16 Credits
This course is repeatable for 24 credits.
Available via Ecampus

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
Equivalent to: ENSC 405H
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.
Available via Ecampus

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.
Available via Ecampus

ENSC 452, ENVIRONMENTAL ASSESSMENT, 3 Credits
Environmental site assessment is a primary tool for environmental science professionals. Apply environmental science concepts to evaluate features of a specific natural area and conduct a land suitability analysis. Create a conceptual site design and management plan that complies with federal, state, and local regulations and environmental laws. CROSSLISTED as ENSC 452/GEOG 452 and GEOG 552.
Equivalent to: GEOG 452
Available via Ecampus

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
Equivalent to: BOT 479
Recommended: One year of college biology or chemistry
Available via Ecampus

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.
Available via Ecampus

ENSC 505, READING AND CONFERENCE, 1-16 Credits
This course is repeatable for 16 credits.
Available via Ecampus

ENSC 506, PROJECTS, 1-16 Credits
PREREQ: Departmental approval required.
This course is repeatable for 16 credits.
Available via Ecampus

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.
Available via Ecampus

ENSC 510, INTERNSHIP, 1-12 Credits
This course is repeatable for 12 credits.
Available via Ecampus
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.
Available via Ecampus

ENSC 516, USING BEST PRACTICES IN ENVIRONMENTAL PROJECT MANAGEMENT, 4 Credits
Explore foundational project management concepts using a real world case-study to practice both soft and hard skills through individual and group assignments, discussions and presentations. Apply best practices, methodologies and tools using a global standards framework to achieve successful outcomes in environmental project management work. Active learning and networking are incorporated throughout the course to provide a full perspective on project management.
Available via Ecampus

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 540, ENVIRONMENTAL SCIENCE PERSPECTIVES ON THE FUTURE OF FOOD, 4 Credits
Examines the newest developments in environmental science research and on-the-ground best management practices for achieving food security and sustainability for growing U.S. and global populations in a dynamic environment and climate.
Available via Ecampus

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.
Available via Ecampus

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.
Available via Ecampus

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)

GEO 003, UNDERGRADUATE RESEARCH, 0 Credits
Engage in research activities appropriate to the discipline; and through the research experience, acquire skills, techniques, and knowledge relevant to the field of study. In consultation with a faculty mentor, engage in research activity, and make and execute a plan for a project.

GEO 004, INTERNSHIP, 0 Credits
Provides basic personal and professional skills that can be used within and outside of a work setting. Through practice, this experience guides students in building and maintaining positive professional relationships, networking/mentoring relationships, and enhances students’ understanding of the connection between theory and practice in their respective disciplines.

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
Available via Ecampus

GEO 199, SPECIAL STUDIES, 1-16 Credits
Equivalent to: GEO 199H
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
Equivalent to: GEO 201H

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
Equivalent to: GEO 201H, GEO 202H

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.
Prerequisite: GEO 201 with C- or better

GEO 301X, GEOSCIENCES DATA ANALYSIS, 4 Credits
Covers problem-based numerical data analysis in the Earth Sciences, with an emphasis on practical skills in visualizing and interpreting geoscience data sets.
Prerequisite: GEO 201 with C- or better and ST 351 [C-]

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
Available via Ecampus

GEO 306, *MINERALS, ENERGY, WATER AND THE ENVIRONMENT, 3 Credits
Formation, occurrence, and use of earth resources including metallic minerals, building materials, energy resources including fossil fuels and nuclear energy, and water resources. Environmental consequences of resource use including surface and groundwater pollution, waste disposal, air pollution and acid rain, and global climate change. Implications of resource use and availability for economic development and geopolitical relations.
Attributes: CSGI – Core, Synth, Global Issues
Available via Ecampus

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
Available via Ecampus

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
Available via Ecampus

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
Prerequisite: WR 121 with C- or better or WR 121H with C- or better
Available via Ecampus

GEO 310, EARTH MATERIALS I: MINERALOGY, 4 Credits
Principles of crystal morphology and structure. Characteristics, identification, and origins of minerals. Lec/lab.
Prerequisite: 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.
Prerequisite: GEO 310 with D- or better
Equivalent to: GEO 310H

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.
Prerequisite: 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 331, *ASTROBIOLOGY: LIFE BEYOND EARTH, 3 Credits
Evaluates the potential distribution of life in the Universe, presents the science and technology used to search for life, and explores the societal impacts of its discovery.
Attributes: CSST – Core, Synthesis, Science/Technology/Society
Recommended: Completion of 12 credits of biological and physical science in the Bacc Core

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.
Prerequisite: GEO 201 with D- or better
Equivalent to: GEO 450

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. Includes 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. (Bacc Core Course)
Attributes: CSST – Core, Synthesis, Science/Technology/Society
Equivalent to: GEO 352H

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, paleooceanography, and tectonics. Lec/lab.
Prerequisite: GEO 201 with C- or better and GEO 203 [C-]
Equivalent to: GEO 470

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
Available via Ecampus

GEO 399, SPECIAL TOPICS, 1-16 Credits
This course is repeatable for 16 credits.
Equivalent to: GEO 399H, GEO 399H

GEO 399H, SPECIAL TOPICS, 1-16 Credits
This course is repeatable for 16 credits.
Equivalent to: GEO 399

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.
Equivalent to: GEO 407H
This course is repeatable for 12 credits.
GEO 407H, SEMINAR, 1-16 Credits
Graded P/N.
Attributes: HNRS – Honors Course Designator
Equivalent to: GEO 407
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.

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.
Prerequisite: GEO 315 with D- or better
Recommended: GEO 415 [C-]

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.
Prerequisite: GEO 201 with D- or better and GEO 310 [D-] and GEO 315 [D-]
Equivalent to: GEO 320

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
Prerequisite: GEO 315 with D- or better

GEO 430, ^GEOCHEMISTRY, 4 Credits
Principles of geochemistry applied to problems of earth science. (Writing Intensive Course)
Attributes: CWIC – Core, Skills, WIC
Prerequisite: 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 233 [D-] or CH 233H [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.
Prerequisite: (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.
Equivalent to: GEO 449
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.
Prerequisite: (PH 211 with D- or better or PH 211H with D- or better) and
(CHA 201 with D- or better or CHA 211H [D-]) and
GEO 322 [D-]
Recommended: MTH 251 [D-] and MTH 252 [D-]

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.
Prerequisite: GEO 315 with D- or better
Recommended: GEO 340 [C-]

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.
Prerequisite: 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
Equivalent to: GPH 463
Recommended: MTH 251 [D-] and (PH 202 [D-] or PH 212 [D-])

GEO 477X, GLACIERS IN THE CLIMATE SYSTEM, 3 Credits
Discusses glaciers as an important component of the cryosphere and the climate of Earth. Examines the physics of glacier formation and flow; glacier interactions with atmosphere, ocean, and landscape. Explores the impact of modern glacier change on water resources and sea level rise. Field trip(s) may be required; transportation fee charged.
Prerequisite: (MTH 251 with C or better or MTH 251H with C or better) and
(MTH 252 [C] or MTH 252H [C]) and
(CHA 201 [C] or CHA 211H [C]) and
(CH 202 [C] or CH 212H [C])

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 [C-]
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.
Prerequisite: 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.
Prerequisite: (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-]))

GEO 487, HYDROGEOLOGY, 4 Credits
Prerequisite: MTH 252 with D- or better or MTH 252H with D- or better

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.
Prerequisite: 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 [C-] and GEO 495 [C-]

GEO 499, SPECIAL TOPICS, 0-16 Credits
Equivalent to: GEO 499H
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 99 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 512, IGNEOUS PETROLOGY, 4 Credits
Petrogenesis of igneous rocks. Petrographic analysis using polarizing microscopes. Field trip may be required, transportation fee charged. Lec/lab.

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.

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.

GEO 530, GEOCHEMISTRY, 4 Credits
Principles of geochemistry applied to problems of earth science.
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.

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

GEO 533, COASTAL GEOMORPHOLOGY, 3 Credits
Morphodynamic approach to coastal landforms, processes and evolution including the impacts and response of humans to coastal change.

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. Prerequisite: 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.

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.

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.

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.

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.

GEO 563, GEOPHYSICS AND TECTONICS, 4 Credits
Geophysical observations as constraints on geologic interpretation. Lec/lab. Equivalent to: GPH 563

GEO 577X, GLACIERS IN THE CLIMATE SYSTEM, 3 Credits
Discusses glaciers as an important component of the cryosphere and the climate of Earth. Examines the physics of glacier formation and flow; glacier interactions with atmosphere, ocean, and landscape. Explores the impact of modern glacier change on water resources and sea level rise. Field trip(s) may be required; transportation fee charged.

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. Offered alternate years.

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.

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.
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 [C-] or GEO 540 [C-]

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 [C-] or GEO 512 [C-]

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. Equivalent to: OC 633

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 GEO 684/SOIL 684. Equivalent to: SOIL 684

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.

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)

GEOG 003, UNDERGRADUATE RESEARCH, 0 Credits
Engage in research activities appropriate to the discipline; and through the research experience, acquire skills, techniques, and knowledge relevant to the field of study. In consultation with a faculty mentor, engage in research activity, and make and execute a plan for a project.

GEOG 004, INTERNSHIP, 0 Credits
Provides basic personal and professional skills that can be used within and outside of a work setting. Through practice, this experience guides students in building and maintaining positive professional relationships, networking/mentoring relationships, and enhances students’ understanding of the connection between theory and practice in their respective disciplines.

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 Equivalent to: GEO 102
Available via Ecampus
GEOG 103, *THE HUMAN PLANET, 3 Credits
Introduces the study of human activities, patterns, processes and institutions–globally and in specific places. Examines human behaviors and relationships, among cultures and with the environment. Demonstrates the importance of places, networks and patterns in a range of human and environmental processes. (Bacc Core Course)
Attributes: CPCD – Core, Pers, Cult Diversity
Available via Ecampus

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 economics in Africa, the Middle East, and Asia. (Bacc Core Course)
Attributes: CPCD – Core, Pers, Cult Diversity
Available via Ecampus

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 economics in Europe and Russia, Australia and Oceania, and the Americas. Lec/rec. (SS) (Bacc Core Course)
Attributes: CPWC – Core, Pers, West Culture; LACS – Liberal Arts Social Core
Equivalent to: GEO 106
Available via Ecampus

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)
Attributes: CPPS – Core, Pers, Physical Science
Equivalent to: GEO 301
Available via Ecampus

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
Available via Ecampus

GEOG 240, *HUMAN DIMENSIONS OF CLIMATE CHANGE, 3 Credits
Examine theories regarding human institutions and behavior. Apply these theories to understand how human behavior and institutions can change to: (1) reduce vulnerability to climate change impacts through adaptation and (2) reduce greenhouse gas emissions through climate change mitigation and societal transformation at multiple scales. (Bacc Core Course)
Attributes: CPSI – Core, Pers, Soc Proc & Inst

GEOG 241, *TRANSFORMING ENVIRONMENTAL CONFLICTS, 3 Credits
Explores the geography of environmental conflicts; an examination of how social processes and institutions influence access and use of natural resources; and the social constructs from which difference, power, and discrimination emerge. Examines the experiences of women, minority, and under-represented communities to contemplate more integrated, equitable and sustainable approaches to resources management, in the United States and beyond. Personal skills in transforming conflicts, as well as the concepts of distributive, procedural, and restorative justice, will be explored. (Bacc Core Course)
Attributes: CPDP – Core, Perspective, Difference/Power/Discrimination

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
Available via Ecampus

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)
Attributes: CPSI – Core, Pers, Soc Proc & Inst
Equivalent to: GEO 205

GEOG 295, GEOGRAPHIC FIELD RESEARCH, 3 Credits
Introduction to field research in geography. Practice skills including observation, posing of questions, and collection and analysis of data. Focus on theory-based geographic study design, proposal development, and research critiques. Recommended: GEOG 102 or GEOG 103 or GEOG 201 or GEOG 203
Available via Ecampus

GEOG 299, SPECIAL STUDIES, 1-16 Credits
This course is repeatable for 16 credits.
GEOR 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
Equivalent to: GEO 300, GEOG 300H
Available via Ecampus

GEOR 300H, *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. (Bacc Core Course)
Attributes: CSGI – Core, Synth, Global Issues; HNRS – Honors Course Designator; LACS – Liberal Arts Social Core
Equivalent to: GEO 300, GEOG 300

GEOR 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)
Attributes: CPCD – Core, Pers, Cult Diversity; LACN – Liberal Arts Non-Western Core
Equivalent to: GEO 325

GEOR 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)
Attributes: CPCD – Core, Pers, Cult Diversity; LACN – Liberal Arts Non-Western Core
Equivalent to: GEO 327

GEOR 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
Equivalent to: GEO 328
Available via Ecampus

GEOR 323, ^CLIMATOLOGY, 4 Credits
Systematic analysis of global and regional climates. Physical principles of climate, climate classifications, and distribution and characteristics of climate regimes. (Writing Intensive Course)
Attributes: CWIC – Core, Skills, WIC
Prerequisite: GEOG 102 with D- or better or GEO 202 with D- or better or GEO 221 with D- or better or ATS 201 with D- or better or OC 201 with C- or better
Equivalent to: GEO 323
Available via Ecampus

GEOR 324, ^ECOLOGICAL BIOGEOGRAPHY, 4 Credits
Spatial distributions and change over time of species, communities, and biomes. Effect of climate, tectonics, disturbance on evolution, extinction, and succession. Implications for conservation. (Writing Intensive Course)
Attributes: CWIC – Core, Skills, WIC
Prerequisite: GEOG 102 with D- or better or (BI 370 with C- or better or BI 370H with C- or better)
Equivalent to: GEO 324

GEOR 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)
Attributes: CSGI – Core, Synth, Global Issues

GEOR 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)
Attributes: CSGI – Core, Synth, Global Issues
Equivalent to: GEO 350

GEOR 332, *CLIMATE AND HEALTH, 3 Credits
Examines how social and environmental determinants of population health are impacted by anthropogenic climate change both spatially and temporally. Introduces theoretical approaches and methods from human-environment geography and public health to construct a cross-disciplinary framework for considering risk, vulnerability, and social justice in relationship to climate change and human health outcomes. Evaluates the influence of political and economic processes on health disparities and inequity. Central focus on the United States, while relying on international perspectives for contextual and comparative purposes. (Bacc Core Course)
Attributes: CPDP – Core, Perspective, Difference/Power/Discrimination
Equivalent to: H 332
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)
Attributes: CSST – Core, Synthesis, Science/Technology/Society
Equivalent to: CSS 335, CSS 335H, GEO 335, GEO 335H, GEOG 340H, SOIL 335
Available via Ecampus

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: CSS 335, CSS 335H, GEO 335, GEO 335H, GEOG 340, SOIL 335

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.
Attributes: CSGI – Core, Synth, Global Issues
Equivalent to: GEO 304
Available via Ecampus

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 to: GEO 365
Available via Ecampus

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. Acquire, clean, integrate, manipulate, visualize and analyze geospatial data through laboratory work.
Prerequisite: GEOG 360 with C- or better and (MTH 112 [C-] or MTH 241 [C-] or MTH 251 [C-]) and ST 351 [C-]
Available via Ecampus

GEOG 362, GIS AND SPATIAL DATA SCIENCE, 4 Credits
Applies spatial thinking and spatial data analysis through the use of GIS and spatial data science. Manipulates, analyzes, and visualizes spatial and temporal data to explore spatial patterns and relationships. Student-designed projects apply principles of spatial data science in terms of spatial technologies as well as problem solving.
Prerequisite: GEOG 360 with C or better and MTH 112 [C] and (ST 314 [C] or ST 351 [C])

GEOG 370, CARTOGRAPHY, 4 Credits
Creation, evaluation, and critique of maps using cartographic theories for effective geovisual communication and geospatial thinking.
Prerequisite: GEOG 201 with C- or better
Available via Ecampus

GEOG 371, WEB MAPPING, 4 Credits
Concepts and techniques of web programming, digital storytelling, online project management, and web-based cartographic principles for developing, evaluating, and using web maps.
Prerequisite: GEOG 201 with C- 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
Available via Ecampus
**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 to: GEOG 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
Prerequisite: 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 to: GEOG 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 to: GEOG 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)
Attributes: CSST – Core, Synthesis, Science/Technology/Society
Equivalent to: GEOG 449

**GEOG 433, CLIMATE CHANGE IMPACTS, ADAPTATION AND VULNERABILITY, 3 Credits**
Climate change poses challenges for human security and well-being, and for social and economic development. Evaluate how climate change impacts vary based on vulnerability, exposure, sensitivity, adaptive capacity, and risk.
Prerequisite: ATS 201 with C- or better or GEOG 240 with C- or better or GEOG 323 with C- or better

**GEOG 440, CONFLICT, COOPERATION, AND CONTROL OF WATER IN THE US, 3 Credits**
Examine why nations rise and fall based on water availability and investigate why the United States is no exception. Explore how the US develops, protects, governs and manages its water resources and how it will cope with climate change and conflict. Discover resilience and sustainability through case studies.
Available via Ecampus

**GEOG 441, THE WORLD’S WATER, 3 Credits**
Investigate why water is a critical resource that supports life, livelihoods, and the environment. Understand that where rivers cross political boundaries, the sharing of water presents challenges and opportunities. Interpret how international basins are governed; Evaluate how dams and water development affect ecology and people; and apply water conflict management frameworks to emerging international water issues.

**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 to: GEOG 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.
Prerequisite: GEOG 360 with C- or better
Available via Ecampus

**GEOG 452, ENVIRONMENTAL ASSESSMENT, 3 Credits**
Environmental site assessment is a primary tool for environmental science professionals. Apply environmental science concepts to evaluate features of a specific natural area and conduct a land suitability analysis. Create a conceptual site design and management plan that complies with federal, state, and local regulations and environmental laws.
CROSSTLISTED as ENSC 452/GEOG 452 and GEOG 552.
Equivalent to: ENSC 452
Available via Ecampus

**GEOG 453, EFFECTIVE COMMUNICATION OF ENVIRONMENTAL CHANGE SCIENCE, 3 Credits**
Explores the state of science on environmental change in the western United States and globally, including population and climate change, and the extent to which human behavior can affect drivers and outcomes of such changes. Develops skills in oral, visual, and written communication of science via both traditional and social media. Examines the best science available standard and addresses debates about advocacy in science.
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.
Prerequisite: GEOG 361 with C- or better
Available via Ecampus

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.
Prerequisite: 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.
Prerequisite: GEOG 360 with C- or better
Recommended: Senior standing
Available via Ecampus

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.
Prerequisite: GEOG 370 with C- or better or GEO 371 with C- or better or GEO 360 with C- or better
Equivalent to: GEO 445

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.
Prerequisite: GEOG 201 with C- or better
Available via Ecampus

GEOG 481, SATELLITE IMAGE ANALYSIS, 4 Credits
Intermediate concepts and techniques for satellite image processing including image enhancement, clustering, classification, machine learning, change detection, and time series analysis. Hands-on experience with open-source, large volume data and geospatial programming within Google Earth engine.
Prerequisite: GEOG 480 with C- or better and (ST 314 [C-] or ST 351 [C-] or ST 351H [C-])

GEOG 495, FIELD GEOGRAPHY SYNTHESIS, 3 Credits
Explore how geographers use field work to investigate landscapes such as mountains, forests, coasts, tundra and desert to understand how they were formed and explain how they have changed over time. Learn techniques for finding out how landscape processes impact humans and, in turn, how humans impact the environment around them. Apply geographic theories and concepts to synthesize, analyze and interpret the relationship between human communities and the environment through the planning and execution of field work.
Prerequisite: GEOG 295 with C- or better
Available via Ecampus

GEOG 499, SPECIAL STUDIES, 0-16 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
Graded P/N.
This course is repeatable for 16 credits.

GEOG 507, SEMINAR, 1-16 Credits
Graded P/N.
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.
Available via Ecampus

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 to: 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 to: GEO 554
Recommended: 9 credits of graduate study.

GEOG 513, QUANTITATIVE METHODS FOR STUDYING SOCIAL-ECOLOGICAL SYSTEMS, 3 Credits
Explores quantitative tools used for studying social-ecological systems. Analyzes the concepts of resilience and fragility in social-ecological systems. Introduces methods from theoretical ecology, computer science, applied math and physics, placing them in the context of sustainability and resilience theory. Introduces network theory, dynamical systems theory and economics.
Recommended: Introductory Statistics with basic programming

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 to: 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 to: 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 to: GEO 523

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 to: GEO 549

GEOG 533, CLIMATE CHANGE IMPACTS, ADAPTATION AND VULNERABILITY, 3 Credits
Climate change poses challenges for human security and well-being, and for social and economic development. Evaluate how climate change impacts vary based on vulnerability, exposure, sensitivity, adaptive capacity, and risk.

GEOG 540, CONFLICT, COOPERATION, AND CONTROL OF WATER IN THE US, 3 Credits
Examine why nations rise and fall based on water availability and investigate why the United States is no exception. Explore how the US develops, protects, governs and manages its water resources and how it will cope with climate change and conflict. Discover resilience and sustainability through case studies.
Available via Ecampus

GEOG 541, THE WORLD'S WATER, 3 Credits
Investigate why water is a critical resource that supports life, livelihoods, and the environment. Understand that where rivers cross political boundaries, the sharing of water presents challenges and opportunities. Interpret how international basins are governed; Evaluate how dams and water development affect ecology and people; and apply water conflict management frameworks to emerging international water issues.

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.
Equivalent to: 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 to: 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.
Prerequisite: GEOG 560 with C or better
Available via Ecampus
GEOG 552, ENVIRONMENTAL ASSESSMENT, 3 Credits
Environmental site assessment is a primary tool for environmental science professionals. Apply environmental science concepts to evaluate features of a specific natural area and conduct a land suitability analysis. Create a conceptual site design and management plan that complies with federal, state, and local regulations and environmental laws. CROSSTLISTED as ENSC 452/GEOG 452 and GEOG 552.
Available via Ecampus

GEOG 553, EFFECTIVE COMMUNICATION OF ENVIRONMENTAL CHANGE SCIENCE, 3 Credits
Explores the state of science on environmental change in the western United States and globally, including population and climate change, and the extent to which human behavior can affect drivers and outcomes of such changes. Develops skills in oral, visual, and written communication of science via both traditional and social media. Examines the best science available standard and addresses debates about advocacy in science.

GEOG 550, 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 (GIsScience).
Equivalent to: GEO 565
Available via Ecampus

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.
Prerequisite: GEOG 560 with C or better
Equivalent to: GEO 580

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.
Prerequisite: GEOG 561 with C or better
Available via Ecampus

GEO 554, 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.
Prerequisite: GEOG 560 with C or better
Available via Ecampus

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 to: 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 to: GEO 584

GEOG 571, ADVANCED WEB MAPPING, 4 Credits
Advanced concepts and techniques of web programming, digital storytelling, online project management, and web-based cartographic principles for developing, evaluating, and using web maps.

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 to: 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.
Recommended: GEOG 201
GEOG 581, SATELLITE IMAGE ANALYSIS, 4 Credits
Intermediate concepts and techniques for satellite image processing including image enhancement, clustering, classification, machine learning, change detection, and time series analysis. Hands-on experience with open-source, large volume data and geospatial programming within Google Earth engine.
Prerequisite: GEOG 580 with C- or better

GEOG 595, FIELD GEOGRAPHY OF OREGON, 3 Credits
Investigate how geographers use field work to study landscapes such as mountains, forests, coasts, tundra and desert to understand how they were formed and explain how they have changed over time. Apply techniques for finding out how landscape processes impact humans and, in turn, how humans impact the environment around them. Apply geographic theories and concepts to synthesize, analyze and interpret the relationship between human communities and the environment through the planning and execution of field work in Oregon.

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 to: GEO 548
Recommended: 9 graduate credits in sciences or engineering.

GEOG 599, SPECIAL STUDIES, 0-16 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)
GPH 501, RESEARCH, 1-16 Credits
Original research work that will not be part of the data used in a thesis.
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.
Prerequisite: 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)

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/HRM 552.
Equivalent to: AEC 552, AREC 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)

OC 003, UNDERGRADUATE RESEARCH, 0 Credits
Engage in research activities appropriate to the discipline; and through the research experience, acquire skills, techniques, and knowledge relevant to the field of study. In consultation with a faculty mentor, engage in research activity, and make and execute a plan for a project.

OC 004, INTERNSHIP, 0 Credits
Provides basic personal and professional skills that can be used within and outside of a work setting. Through practice, this experience guides students in building and maintaining positive professional relationships, networking/mentoring relationships, and enhances students’ understanding of the connection between theory and practice in their respective disciplines.

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
Equivalent to: GEO 103H, OC 103H
Available via Ecampus

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: CPBS – Core, Pers, Biological Science
Equivalent to: OC 331H
Available via Ecampus

OC 202, *INTRODUCTION TO BIOLOGICAL OCEANOGRAPHY, 4 Credits
Explores critical topics to biological oceanography, including: the interaction of ocean life, past and present, with its chemical, physical, and geological environment; how ocean life captures energy to produce food and affect climate; and how historical sea-faring observations shaped our understanding of ocean life relative to current technological advances.
Attributes: CPBS – Core, Pers, Biological Science

OC 205, INTRODUCTION TO FIELD OCEANOGRAPHY - LAND, 1 Credit
OC 205 is preparatory for the intensive OC 296 field portion at sea.
Students will learn about the collection of samples and data using methods and instruments that are common in sea-going oceanography and help plan the cruise.
Prerequisite: OC 201 (may be taken concurrently) with D- or better

OC 295, 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.
Prerequisite: 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.
Equivalent to: OC 332H

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
Prerequisite: 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 emphasis 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/OC 434 and FW 534/OC 534.
Equivalent to: FW 434
OC 436, ACOUSTICAL OCEANOGRAPHY, 3 Credits
Explore the principles of using sound as a sampling tool and the applications of acoustics in a variety of marine disciplines. Examine the physics of underwater sound and sound propagation in the ocean, including the effects of oceanographic variability such as temperature/salinity stratification, seafloor/surface reflections, internal waves, turbulence, and presence of biological organisms. Break down the principles underlying acoustic remote sensing methods in oceanography including sonar, sub-bottom profilers, acoustic tomography, and passive acoustic detection. Explore modern research in acoustical oceanography, and the associated scientific literature.
Prerequisite: PH 213 with C or better and OC 430 [C]

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.
Prerequisite: 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.
Prerequisite: (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.
Prerequisite: 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 453, CHEMISTRY OF NATURAL WATERS, 4 Credits
Explores fundamental concepts for understanding the thermodynamics and kinetics of chemical changes in natural waters. Applies techniques for predicting the speciation and reactions of gaseous, dissolved and solid phases, with an emphasis on quantifying equilibrium chemistry. Focuses on a range of natural environments including oceans, rivers, lakes, groundwaters, and soils in order to develop an intuition of the behavior of chemicals in nature. Emphasizes acid-base chemistry, gas-liquid equilibrium, metal chemistry, surface chemistry, oxidation and reduction chemistry.
Prerequisite: CH 123 with C- or better or CH 233 with C- or better or CH 233H with C- or better

OC 460, GEOLOGICAL OCEANOGRAPHY, 4 Credits
Explores the (primarily) sedimentary processes in the ocean and their stratigraphic significance. Topics include how sediment is delivered to (or produced in) in the ocean; how waves, currents, and gravity redistribute it; and how it accumulates in various depositional environments to form the stratigraphic record. The challenge of deciphering sedimentary archives to better understand Earth history on time scales of events to millions of years will also be explored.
Prerequisite: OC 201 with C- or better and GEO 201 [C-]
Recommended: One year each of physics and chemistry or science background.

OC 495X, ADVANCED FIELD OCEANOGRAPHY 1, 2 Credits
Design a ship-based research project and contribute to the preparation and planning for a related oceanographic cruise.
Prerequisite: (OC 430 with C- or better or OC 440 with C- or better or OC 450 with C- or better or OC 460 with C- or better) and (OC 430 [C-] or OC 440 [C-] or OC 450 [C-] or OC 460 [C-])
Recommended: Senior standing

OC 496X, ADVANCED FIELD OCEANOGRAPHY 2, 4 Credits
Participate in an oceanographic cruise to collect data and samples. Analyze data and samples and prepare a written report of findings.
Prerequisite: OC 495X with C- or better
Recommended: Senior standing

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.
Equivalent to: OC 499H
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.
Prerequisite: OEAS 540 with C or better
Corequisites: OC 522, OC 523
Equivalent to: G 521

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.
Equivalent to: GEO 528

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/OC 434 and FW 534/OC 534.
Equivalent to: FW 534

OC 536, ACOUSTICAL OCEANOGRAPHY, 3 Credits
Explore the principles of using sound as a sampling tool and the applications of acoustics in a variety of marine disciplines. Examine the physics of underwater sound and sound propagation in the ocean, including the effects of oceanographic variability such as temperature/salinity stratification, seafloor/surface reflections, internal waves, turbulence, and presence of biological organisms. Break down the principles underlying acoustic remote sensing methods in oceanography including sonar, sub-bottom profilers, acoustic tomography, and passive acoustic detection. Explore modern research in acoustical oceanography, and the associated scientific literature.
Recommended: Background in oceanography or a fluid dynamics related discipline; physics that included wave propagation (e.g., electromagnetics); and mathematics that included differential equations
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 553, CHEMISTRY OF NATURAL WATERS, 4 Credits

Explores fundamental concepts for understanding the thermodynamics and kinetics of chemical changes in natural waters. Applies techniques for predicting the speciation and reactions of gaseous, dissolved and solid phases, with an emphasis on quantifying equilibrium chemistry. Focuses on a range of natural environments including oceans, rivers, lakes, groundwater, and soils in order to develop an intuition of the behavior of chemicals in nature. Emphasizes acid-base chemistry, gas-liquid equilibrium, metal chemistry, surface chemistry, oxidation and reduction chemistry.

Recommended: One year of college-level chemistry

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/OC 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, seiching, and storm surge.

CROSSLISTED as CE 630/OC 630.

Equivalent to: CE 630

OC 631, OCEAN WAVE MECHANICS II, 3 Credits

Second in the sequence of ocean wave engineering 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/OC 631.

Prerequisite: 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/OC 634.

Prerequisite: 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. The focus is on review of model requirements, detailed study of several specific models for several domains of interest, application to coastal phenomena, and the interpretation of model results. Offered alternate years. 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. Prerequisite: 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 hydraulics.

OC 666, THEORETICAL PETROLOGY, 3 Credits

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. Prerequisite: 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. Prerequisite: 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.
Prerequisite: 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.
Prerequisite: 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.
Prerequisite: 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.
Prerequisite: 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.
Prerequisite: 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.
Equivalent to: ATS 683
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)

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