GEOLOGY DEPARTMENT STUDENT HANDBOOK

SEPTEMBER 2013

Department of Geology
Eastern Washington University
Cheney, Washington 99004
September 2013

Telephone: (509) 359-2286
Fax: (509) 359-4386

Email: geol@ewu.edu
Web: http://www.ewu.edu/cshe/programs/geology.xml
Geology as a Career

• Do you enjoy the outdoors? Do you like to travel? Would you like someone to pay you to explore mountains, deserts, rivers, canyons, beaches, or caves? Do you care about the environment and the future quality of life for yourself, your children, your grandchildren? If so, then geology may be the career for you.

• Geology is a profession for people who prefer to work outside, and who want to explore fundamental questions about how the earth works. Geologists are scientists who work to improve the quality of human life by investigating such geologic hazards as earthquakes, landslides, floods, volcanic eruptions, and groundwater contamination. Geologists often work with engineers in making geologic studies of sites for such things as power plants, bridges, landfills, or radioactive waste disposal. If our present lifestyle is to continue, geologists must find critical amounts of energy and metallic mineral resources, and develop drinking water supplies of high-quality groundwater for expanding populations.

• Computers play a critical role in helping geologists do their work. Computers help analyze and interpret data collected by geologists. Computers use data to generate maps and produce images such as those received from planetary exploration. Computers simulate earthquakes, model groundwater flow, and analyze satellite data in mineral exploration. A geology career is also a career utilizing powerful computing tools and computer graphics. In a laboratory setting, computers are often used to control analytical equipment.

• Geologists are employed by major corporations and by small startup companies involved in oil, natural gas, and mineral exploration. Many are employed by state and federal departments of natural resources or ecology and by engineering and environmental consulting firms. Some, like the faculty at EWU, teach at the university level, while others choose earth science teaching in middle or high schools.

• According to the Bureau of Labor Statistics (BLS), jobs in the geosciences are expected to grow by 22 percent between 2006 and 2016. This is a much faster increase in employment than the average for all occupations. Geoscientists with Master’s degrees are expected to have the most employment opportunities of all degreed geoscientists.

• Salary estimates released by BLS for 2008 indicated that the mean annual salary for geoscientists was $89,300. Geoscientists in the petroleum and mining industries earned the highest salaries ($95,200 - $130,620) and those in state government earned the least ($59,830). Geoscientist faculty earned a mean annual salary of $74,770 in 2008. Additionally, according to the National Association of Colleges and Employers, average starting salaries for college graduates with geoscience bachelor’s degrees were $40,786 in 2007. For more detailed information, visit the American Geological Institute web site at www.agiweb.org.

Undergraduate Studies in Geology at EWU

• The faculty and staff of the Department of Geology at Eastern are proud of our outstanding undergraduate programs in which students are in relatively small classes, receive individual attention, and ready access to professors both inside and outside of the classroom. The faculty members, all of whom hold a Ph.D. degree, are active scholars and seek to involve students in their research projects. Faculty members teach in their areas of research and bring the benefits of their special experiences and expertise to the classroom. Outstanding seniors may elect to do a senior thesis with a faculty mentor in an area of interest.

• The department offers majors in Geology (B.A. and B.S.); there is also a B.S. in Environmental Science with Geology emphasis. For students interested in K-12 teaching, we have a B.A.E in Earth and Space Science/Secondary with appropriate minors for both the elementary and secondary school teaching certificates.

• The Geology Department has offices, laboratories and equipment located on the first floor of the Science Building. The Department office is located in room 130, and the Department office manager will be happy to arrange a tour for interested persons.

• Eastern students have the opportunity for “hands-on” experience with scientific equipment that is often used by graduate students in larger research universities. The geochemistry lab is equipped with state-of-the-art instruments including an inductively coupled plasma optical emission spectrometer (ICP-OES) and a UV-Vis spectrophotometer. The mineralogy and petrology laboratory contains a number of Olympus polarizing light microscopes that were recently purchased.

• The department sponsors an active Geology Club run by and for students. The club hosts guest speakers, organizes and runs field trips, and brings back alumni to speak on employment opportunities for Eastern graduates.

• Faculty advising is important for maximizing student success. Our goal is that our students will graduate on time and with the right skills for their future success. Because of this, we urge majors to see their geology advisor (each quarter) before registering. This is an opportunity for students to make sure they are taking the appropriate courses, have the proper prerequisites, or ask questions and seek guidance about their life as students and after graduation.
Financial Support

Several types of financial aid are available to students. Some of our students work as teaching assistants in the numerous laboratory sessions. Many students qualify for work-study support. There are numerous grants and scholarships at the university level. The Geology Department has three (Mutschler Scholarship, Weissenborn Scholarship and the Rock Rollers Scholarship) for our outstanding seniors. We also have a cooperative agreement with the U.S. Geological Survey in Spokane that allows us to hire student assistants for USGS projects. Student loans are also available. For more information, contact the Geology Department or the Financial Aid office at (509) 359-2314 or visit http://www.ewu.edu/admissions/financial-aid.xml

The Geology Faculty at EWU

Dr. John P. Buchanan joined the faculty in 1984. He received his Ph.D. at Colorado State University in 1985. He primarily teaches courses related to hydrogeology, geologic hazards, sedimentology and stratigraphy, as well as surficial geology and spring and summer field courses. His research interests lie in delineating regional aquifer systems and directing reconnaissance level hydrogeologic and groundwater quality investigations. He is active in consulting.

Dr. Linda B. McCollum joined the faculty in 1983. She received her Ph.D. from the State University of New York at Binghamton. She teaches historical geology, environmental geology and geology of Eastern Washington as well as spring field courses. Her research interests have been primarily in Paleozoic faunas, stratigraphy, and Eastern Washington geology.

Dr. Carmen A. Nezat joined the faculty in 2007. She received her Ph.D. at the University of Michigan in 2006. She teaches courses in environmental science, geochemistry, isotope geology, general geology courses and field camp. Her research interests are in soil and water geochemistry, mineral weathering, and biogeochemistry.

Dr. Richard L. Orndorff joined the faculty in 2003. He received his Ph.D. at Kent State University in 1994. He teaches courses in engineering geology, surficial geology, general geology, a capstone course and field camp and spring field courses. His research interests are in geomorphology, glaciation, engineering geology and GIS. He co-teaches Field Camp in Dillon, MT.

Dr. Chad Pritchard served as a lecturer from 2011 - 2013. In 2013, he was hired in a tenure-track position. He received his Ph.D. at Washington State University in 2011. He teaches Physical Geology and our two structural geology courses. He has mentored undergraduate independent research projects that have published abstracts on strain analysis of deformed trilobites, U-Pb dating of local granitoids, and structural analysis of local faults/ fracture patterns. His research interests are in structural geology, igneous petrology and geochronology. He co-taught Field Camp in Dillon, MT during the summer of 2012 and will be involved with the camp in the future.

Dr. Jennifer A. Thomson joined the faculty 1996. She received her Ph.D. from the University of Massachusetts in 1992. She teaches Earth materials, crystallography and optical mineralogy, igneous and metamorphic petrology, volcanology, various introductory geology courses and summer field courses. Her research interests are in understanding the pressure and temperature conditions of metamorphism and partial melting of metamorphic rocks. She is active in consulting for junior exploration companies.

Special Faculty

Ms. Jeanne Case, part-time lecturer, joined the Department of Geology in 2007. She currently teaches sections in GEOL 100 and an on-line GIS (Geographic Information Systems) course and participates in co-teaching Field Camp in Dillon, MT.

Ms. Sharen Keattch, full-time lecturer, advises students in the Earth and Space Science program, teaches general geology courses, Earth Science teaching methods and co-teaches Field Camp in Dillon, MT. She is active in Science Olympiad.

Support Staff

Mr. Nigel Davies, Instructional Technician, is in charge of the thin section lab, as well as the map library and other departmental equipment. He teaches one section of GEOL 100 every quarter, organizes the labs for all GEOL 100 sections and supervises undergraduate teaching assistants.

Ms. Carolyn Harbolt, Office Manager, manages the department office. If you have a general question about the University, have misplaced an item or need any kind of assistance while at Eastern, Carolyn is here to help you. The Department of Geology office number is (509) 359-2286 and Ms. Harbolt’s email is charbolt@ewu.edu
Degree Requirements
Many geology courses have prerequisites, and you should include these in your planning. Chemistry and Math should be taken early in your program. You should also be aware of the General Education requirements, which include the following:

- University Competencies/Proficiencies: Mathematics, English Composition, Computer Literacy
- Core Areas: Natural Science, Social Science, Arts & Humanities
- Graduation Requirements: Cultural & Gender Diversity, International Studies, Capstone

Course requirements in each program are presented at the end of this packet (from the 2013-2014 course catalog).

Life After Graduation...Graduate School or a Job???
Graduate School – If you are planning a career in geology we highly recommend that you continue your studies in graduate school. Entry-level salaries in the work force increase with degrees earned. You will be more marketable with a graduate degree.

When do you start looking at graduate schools? You should begin to think about where you want to go to graduate school early in your Senior year; graduate school applications are often due in December or January. Be sure that you discuss your goals with appropriate faculty members. We are here to help you and may be able to guide you to specific programs capable of handling your interests. Write to six or more graduate schools requesting information about their faculty and programs. Make sure that there is a faculty member at the school with interests similar to yours; that faculty member might be your thesis advisor if you enter that graduate program. Once you have narrowed your search, it is a good idea to visit the school(s) in which you are interested. You can do a “virtual tour” of many schools and geology departments using the Internet if an on-site visit is not possible. A good beginning source of information about graduate programs is available in the Department of Geology Office: Directory of Geoscience Departments, published by the American Geological Institute. Many graduate programs send us fliers, which are posted in the hallway between rooms 107 and 109. Other sources are found in the library or on the Internet.

What is expected for admission into a graduate program? Graduate schools examine your undergraduate G.P.A. Typically, a minimum G.P.A. of 3.0 is necessary for graduate program admission. You will also be required to take the Graduate Record Examination (GRE). There are books available to help you to prepare for these standardized examinations. Look at the GRE Web site at www.gre.org/index.html for information about the examination, including sample questions. The GRE should be taken early in your Senior year. Graduate schools also require letters of recommendation from at least 3 professors. A professor is able to write a letter only if he/she knows you well. Make it a point to get to know your professors through coursework, conversations, field trips and independent study projects. If you don’t do these things, a professor may not be able to write you a good letter of recommendation. In addition, Directed Studies and Independent Projects done during your Junior or Senior years are extremely valuable in preparing you for graduate school. A research project may include a written report and/or an oral presentation. Both writing and speaking skills are required for nearly all careers in geology. If you are going on to graduate school, the successful completion of an independent undergraduate research project is a good indication that you are capable of completing a research project at the graduate level. A summer field camp in geology is expected by many graduate schools and potential employers; field camp is typically done after the Senior year as your final course requirement. The Department of Geology offers a four-week field camp in Dillon, MT immediately following spring quarter.

How am I going to pay for graduate school? Most graduate program applications are due in December and January. The earlier you get your application in, the better the chances for receiving partial or full financial aid packages. Some financial aid packages are in the form of teaching and/or research assistantships. There are also fellowship and grant opportunities available to graduate students. Don’t let money stop you from attending graduate school - there are alternatives.

The Work Force – If graduate school is not in your plans, you are probably going to look for a job within the geological work force. Finding a job is not easy. Many geology positions require you to relocate either in the U.S. or overseas. The trick in finding a job is to prepare a good resume and cover letter (which will vary depending on the nature of the position), and to follow up job announcements. You may find job announcements in newspapers and geological journals. You may also find geoscience job announcements on the Internet (just enter Geology Jobs and you’ll see lots of hits). Many
potential employers will want to examine your university transcripts. Your transcript is available from each University that you have attended and lists the courses that you successfully completed along with the grade you earned in each and your G.P.A. Your transcript also indicates courses from which you withdrew or received an incomplete grade. Numerous withdrawals and incompletes do not look good to prospective employers - avoid them! Finally, while you are an undergraduate at EWU, do look into summer internships with local mining, environmental consulting, and hydrology companies or federal and state agencies. An internship will give you the opportunity to gain some hands-on

**Examples of Jobs of EWU Geology Graduates**

Manager, AGRA Earth & Environmental, Inc.
Hydrologic Technician, U.S. Geological Survey
Environmental Scientist, Hanford
Regional Geochemist, Newmont Exploration Co.
Project Hydrogeologist, Harding Lawson Associates
Superintendent for Underground Mine Planning, Freeport Indonesia
Principal Geologist, Secor International, Inc.
Groundwater Department Manager, Lockheed Martin Idaho Technology
Regional Geologist, Washington Department of Natural Resources
Hydrologist, U.S. Geological Survey Water Resources Division
Environmental Geologist, Fulcrum Environmental Consulting
Professor, Shepherd College
Senior Processing Geophysicist, Geotrace Technologies
President, Brennan Resources Ltd.
Geophysical Systems Analyst, Aramco
Office Manager, Maxim Technologies
Vice President and Assistant General Consul, Indochina 2000, Inc.
Forensic Scientist, Washington State Crime Lab
8th Grade Earth Science Teacher
Assistant Professor, University of New Mexico
Fire River Gold, Alaska

**Graduate Schools Attended by EWU Geology Graduates**

University of Alaska, Fairbanks
University of Arizona
Arizona State University
Baylor University
University of California, Santa Barbara
Colorado School of Mines
Harvard University
University of Idaho
University of Illinois
Indiana University
University of Kansas
University of Minnesota
University of Montana
University of Nevada, Las Vegas
University of Nevada, Reno
New Mexico Institute of Mining and Technology
Northern Arizona University
Portland State University
University of Oklahoma
University of Ottawa
Queen’s University
Sul Ross State University
University of Saskatchewan
Texas A&M University
University of Toronto
University of Washington
Washington State University
Washington University
University of West Virginia
Western Washington University
GEOLOGY

Jennifer Thomson, Chair.
130 Science Bldg. 509.359.2286 charbolt@ewu.edu www.ewu.edu/geology


UNDERGRADUATE PROGRAMS

Geology is the science of planet Earth. Geologists use elements of chemistry, physics, biology and mathematics in interpreting the evolution of the earth and its life forms. Applied geology addresses exploitation of earth resources, environmental quality and hazards and practical understanding of the planet on which we live.

Geology is a field-oriented science and our curriculum emphasizes field studies. However, geologists increasingly employ advanced chemical and physical analytic techniques and use computers to model natural systems. Eastern has specialized laboratory facilities for various sub-disciplines in geology. Extensive collections of minerals, rocks and fossils are available for study and research.

Nationwide, approximately half of recent geology graduates are employed in environmental fields while a third go on to graduate school. Most of the rest go into the petroleum industry, teaching, government or mining. The Geology Department has close relations with geotechnical/environmental consulting firms, government agencies and mining companies in the Pacific Northwest. These relationships help to place students and graduates in jobs.

Students should decide on a geology major early to ensure timely graduation with the many credits needed in the Bachelor of Science program. Substitutions of courses in the Geology major must be approved by the department. Most graduate schools require a full year of calculus. An opportunity exists to earn a double major with a BS in both Geology and Environmental Science. (See catalog section on Environmental Science.)

General Admissions Requirements for Geology

High school students planning to major in Geology should take two years of algebra, one year of geometry/trigonometry and one year of chemistry and physics. They are also encouraged to take four years of English. The ability to express ideas and concepts clearly and concisely, both orally and in written form, is fundamental to all sciences.

Entering freshmen and transfer students electing to major in Geology should contact the Department for advising as soon as possible. Failure to do so may result in an additional year to finish the BS program. Especially important for beginning students is early completion of the chemistry sequence.

Grade Requirement

2.50 cumulative average

2.0 in required supporting and geology classes

Required courses in the following programs of study may have prerequisites. Reference the course description section for clarification.

BACHELOR OF ARTS (BA)

Student Learning Outcomes—students will:

- demonstrate effective skills in oral and written communication in order to be successful in the field of geology;
- demonstrate an understanding of basic principles of the history and development of the earth through time;
- demonstrate the proper use of computer, laboratory, and field equipment used in geology.

GEOLGY MAJOR (66–72 CREDITS)

The Bachelor of Arts serves students interested in geology-oriented fields which do not require the full range of professional training. Employment opportunities include such varied possibilities as park naturalist, urban and regional planner or geological technician.

Note: two years of a single high school foreign language or one year of a single college level foreign language is required.

Required Courses (31–37 credits)

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOL 120</td>
<td>Physical Geology: The Solid Earth</td>
<td>5</td>
</tr>
<tr>
<td>GEOL 121</td>
<td>Physical Geology: Surficial Processes</td>
<td>5</td>
</tr>
<tr>
<td>GEOL 122</td>
<td>Historical Geology</td>
<td>5</td>
</tr>
<tr>
<td>GEOL 311</td>
<td>Earth Materials</td>
<td>4</td>
</tr>
<tr>
<td>GEOL 312</td>
<td>Crystallography and Optical Mineralogy</td>
<td>4</td>
</tr>
<tr>
<td>GEOL 313</td>
<td>Igneous and Metamorphic Petrology</td>
<td>4</td>
</tr>
<tr>
<td>GEOL 490</td>
<td>Senior Capstone: Geology Field Camp</td>
<td>10</td>
</tr>
<tr>
<td>or GEOL 491</td>
<td>Senior Thesis</td>
<td>4</td>
</tr>
</tbody>
</table>

Required Supporting Courses (10 credits)

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 151</td>
<td>General Chemistry</td>
<td>5</td>
</tr>
<tr>
<td>CHEM 152</td>
<td>General Chemistry</td>
<td>5</td>
</tr>
</tbody>
</table>

Choose one from the following (5 credits)

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 171</td>
<td>Biology I</td>
<td>5</td>
</tr>
<tr>
<td>GEOG 328</td>
<td>Geographic Information Systems I</td>
<td>5</td>
</tr>
<tr>
<td>GEOG 410</td>
<td>Geomorphology</td>
<td>5</td>
</tr>
<tr>
<td>MATH 161</td>
<td>Calculus I</td>
<td>5</td>
</tr>
<tr>
<td>MATH 380</td>
<td>Elementary Probability and Statistics</td>
<td>5</td>
</tr>
<tr>
<td>PHYS 131</td>
<td>Introductory Physics</td>
<td>4</td>
</tr>
<tr>
<td>and PHYS 161</td>
<td>Mechanics Lab</td>
<td>1</td>
</tr>
</tbody>
</table>

Electives (20 credits)

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOL 320</td>
<td>Environmental Geology</td>
<td>4</td>
</tr>
<tr>
<td>GEOL 360</td>
<td>Geologic Hazards</td>
<td>4</td>
</tr>
<tr>
<td>GEOL 408</td>
<td>Invertebrate Paleontology</td>
<td>4</td>
</tr>
<tr>
<td>GEOL 411</td>
<td>Sedimentology and Stratigraphy</td>
<td>4</td>
</tr>
<tr>
<td>GEOL 430</td>
<td>Structural Geology I</td>
<td>4</td>
</tr>
<tr>
<td>GEOL 431</td>
<td>Structural Geology II</td>
<td>4</td>
</tr>
<tr>
<td>GEOL 470</td>
<td>Hydrogeology</td>
<td>4</td>
</tr>
</tbody>
</table>

Geology field course (up to 5 credits)

Minimum total credits for above major 66 credits

ewu graduate and undergraduate catalog 2013–14
BACHELOR OF SCIENCE (BS)
Student Learning Outcomes—students will:

• demonstrate effective oral and written communication skills necessary for employment in the various fields of geology;
• demonstrate critical thinking skills to solve geological problems encountered in the various fields of geology;
• use the tools and equipment available to professional geologists to solve geological problems;
• demonstrate a solid understanding of geologic principles and processes that operate in the complex systems of the earth.

GEOLOGY MAJOR (108 CREDITS)
The Bachelor of Science program prepares students for careers as professional geologists, provides the basis for admission to graduate school and prepares students seeking registration and licensing as professional geologists. Some courses in the BS degree will also count as Natural Science GECRs and satisfy the university proficiency in mathematics requirement.

Required Courses (53 credits)
- GEOL 120 Physical Geology–The Solid Earth (5)
- GEOL 121 Physical Geology–Surficial Processes (5)
- GEOL 122 Historical Geology (5)
- GEOL 311 Earth Materials (4)
- GEOL 312 Crystallography and Optical Mineralogy (4)
- GEOL 313 Igneous and Metamorphic Petrology (4)
- GEOL 408 Invertebrate Paleontology (4)
- GEOL 411 Sedimentology and Stratigraphy (4)
- GEOL 430 Structural Geology I (4)
- GEOL 431 Structural Geology II (4)
- GEOL 490 Senior Capstone: Geology Field Camp (10)

Required Supporting Courses (43 credits)
- CHEM 151 General Chemistry (5)
- CHEM 152 General Chemistry (5)
- CHEM 153 General Chemistry (5)
- GEOG 323 GIS for Environmental Science (3)
- MATH 161 Calculus I (5)
- MATH 162 Calculus II (5)
  or MATH 380 Elementary Probability and Statistics (5)

Choose one of the following sequences
- BIOL 171 Biology I (5)
- BIOL 172 Biology II (5)
- BIOL 173 Biology III (5)
  or
- PHYS 131 Introductory Physics I (4)
- PHYS 132 Introductory Physics II (4)
- PHYS 133 Introductory Physics III (4)
- PHYS 161 Mechanics Lab (1)
- PHYS 162 Heat and Optics Lab (1)
- PHYS 163 Instrumentation Lab I (1)
  or
- PHYS 151 General Physics I (4)
- PHYS 152 General Physics II (4)
- PHYS 153 General Physics III (4)
- PHYS 161 Mechanics Lab (1)
- PHYS 162 Heat and Optics Lab (1)
- PHYS 163 Instrumentation Lab I (1)

Electives (12 credits)
Select credits from Geology courses, eight of which must be upper-division.

Required program credits: 53 credits
Required supporting credits: 43 credits
Elective credits: 12 credits
Minimum total credits for above major: 108 credits

MINOR
GEOLOGY MINOR (23–24 CREDITS)
Required Courses
- GEOL 120 Physical Geology–The Solid Earth (5)
- GEOL 121 Physical Geology–Surficial Processes (5)
- GEOL 122 Historical Geology (5)
- GEOL 311 Earth Materials (4)
- Geology elective (4–5)

Total credits for above minor: 23 credits

Bruce Bjornstad, EWU alumnus and Eugene Kiver, EWU Geology professor emeritus.
Geology Courses

Terms offered: fall, winter, spring, summer (FWSU).
If no terms are indicated, check with the department or EagleNET.

GEOL 100  Discovering Geology (5) FWSU
Satisfies: a GECR for natural sciences, geology.
This course explores the interactions between human beings and their geological environment. The earth is a dynamic planet affected by sudden, violent events such as volcanic eruptions, earthquakes and floods, as well as by slower processes operating over long time spans that create, move and destroy continents and oceans. Other topics include study of energy, mineral and water resources and their importance to modern society. Topics are presented at a level intended for non-science majors. Satisfies lab science requirement at most universities.

GEOL 115  Investigating Earth Science (5) FS
Cross-listed: GEGO 115.
Prerequisite: pre-university basic skills in mathematics.
Satisfies: a GECR for natural sciences, geology.
For students planning to teach elementary school. Includes inquiry-based earth science investigations that support science instruction outlined in the National Science Education Standards and Washington Essential Academic Learning Requirements.

GEOL 120  Physical Geology–The Solid Earth (5) FW
Note: the completion of GEOL 120 counts as one course for the GECR in natural sciences, geology; the completion of GEOL 121 and 122 counts as two courses for the GECR in natural sciences, geology.
Prerequisites: two semesters of high school chemistry, MTHD 104 or equivalent.
Introduction to physical geology for students interested in earth and environmental science. This course covers the origin of the earth, its internal structure and minerals, rocks and volcanoes. Earthquakes, mountains and continental drift are discussed in the context of plate tectonics. The formation of mineral deposits is also covered. Weekly laboratories and one field trip are required.

GEOL 121  Physical Geology–Surficial Processes (5) WS
Note: the completion of GEOL 121 counts as one course for the GECR in natural sciences, geology; the completion of GEOL 120 and 121 counts as two courses for the GECR in natural sciences, geology.
Prerequisites: computer literacy, MTHD 104 or equivalent.
Introduction to physical geology for students majoring in geology, earth science or environmental science. This course emphasizes the quantitative analysis of processes that shape the earth's surface (gravity, wind, water and ice) including weathering and erosion, the creation of sediments and sedimentary rocks and the development of landforms. Energy resources and the concept of earth systems are also explored. Weekly laboratories and one field trip are required.

GEOL 122  Historical Geology (5) WS
Prerequisite: GEOL 121.
Introduction to earth history for students majoring in geology, earth science or environmental science. This course covers the diversity of life, catastrophic extinctions and the effect of biologic change on the environment. The basic principles of stratigraphy, use of stable isotopes to interpret sedimentary environments and the stratigraphic and tectonic history of the earth are also explored. Other topics include identification of the common fossil groups, survey of the fossil record in the context of geological evolution and practice using geologic maps. Weekly laboratories and one field trip are required.

GEOL 297  Workshops, Short Courses, Conferences (1–5)
At a lower division level.

GEOL 299  Special Studies (1–5) FWSU
Prerequisite: permission of the instructor, department head.
Topics vary with interest of student and instructor.

GEOL 311  Earth Materials (4) F
Prerequisites: GEOL 120 and CHEM 151.
This course is an introduction to the materials that comprise the solid earth, including minerals, igneous, sedimentary and metamorphic rocks. The course includes discussions of their occurrence, associations and uses. Methods of identification are stressed during laboratory exercises.

GEOL 312  Crystallography and Optical Mineralogy (4) W
Prerequisite: GEOL 311.
This second course of a three-course series covers how to describe the external morphology of well-formed crystals using crystallographic techniques. In addition, the techniques of optical mineralogy using a petrographic microscope are introduced as a tool for identifying rock-forming (silicate) minerals.

GEOL 313  Igneous and Metamorphic Petrology (4) S
Prerequisites: GEOL 311 and 312.
The third course in a series is a comprehensive study of the classification, description and origin of igneous and metamorphic rocks. Students will learn about the use of minerals in helping to interpret the geologic and tectonic significance of the rocks in which they are found. The course builds on skills learned in GEOL 311 and 312 and stresses hand sample and thin section descriptive techniques. Weekly laboratories as well as one weekend field trip are required. Additional field trips may be offered.

GEOL 315  Physical Geology–The Surficial Environment (4) W
Prerequisite: GEOL 100, 120 or 121.
Relationship of human activities with earth materials and processes, water quality, soils, weathering and erosion, the creation of sediments and sedimentary rocks and the development of landforms. Energy resources and the concept of earth systems are also explored. Weekly laboratories and one field trip are required.

GEOL 320  Environmental Geology (4) W
Prerequisite: GEOL 100, 120 or 121.
Study of the origin of sediments and sedimentary rocks for advanced geology majors. Description and interpretation of facies and environments of deposition and classification of clastic and chemical sedimentary rocks is emphasized. Stratigraphic principles, nomenclature and correlation is also treated. Lecture and weekly laboratory.

GEOL 325  Geology of the Colorado Plateau (4) FWSU
Cross-listed: GEOL 121, GEOL 122 or permission of the instructor.
Study of the geology of the Colorado Plateau, specifically in Arches and Canyonlands National Parks. Geologic evolution and structural geology of the region will be discussed and the ancient sedimentary environments of deposition will be emphasized. A field trip will be held during the week of spring break.

GEOL 326  Geologic Hazards (4) F
Prerequisite: GEOL 100, 115, 120, 121 or GEOG 100 or GEOG 115.
Introduction to geologic hazards affecting humankind; emphasis on earthquakes, volcanism, floods and landslides. Applications to geologic site engineering and city/ regional planning.

GEOL 330  Discovering Women in Science (1)
Cross-listed: BIOL, CHEM, HIST, PHYS, PSYC, WAST 138.
The course uses several scientific themes to rediscover from the past and find in contemporary research, the women who have made significant contributions to science.

GEOL 335  Structural Geology I (4)
Prerequisite: GEOL 100, 120, 121 or GEOG 100 or GEOG 115.
Introduction to structural geology for students majoring in geology. The use of stereo photometry and mechanical modeling to understand geologic processes and the structural evolution of rocks is emphasized. Weekly laboratory exercises. Designed to be taken in series with GEOL 431.

GEOL 336  Structural Geology II (4)
Prerequisite: GEOL 335.
Continuation of an introduction to structural geology for students majoring in geology. Continuation of an introduction to structural geology, the study of geologic structure and its relationship to the origin and evolution of rocks. Weekly laboratory exercises. Designed to be taken in series with GEOL 335.

GEOL 380  World Resources and Population (5)
Satisfies: international studies university graduation requirement.

GEOL 389  Earth Science Teaching Methods (1) F
Cross-listed: GEOL 390.
Prerequisite: GEOL 120, GEOL 121, GEOG 314, PHYS 121, EDUC 363 or permission of the instructor. SCED 390 co-requisite.
This course is designed for Earth Science majors planning to teach middle school, junior or senior high school. It includes the development of curriculum and the organization of teaching materials, techniques and evaluation.

GEOL 408  Invertebrate Paleontology (4) S
Prerequisites: GEOL 120 and GEOL 311.
Principles of paleontology including methods of description and analyses of invertebrates. Emphasis on principles of morphology and evolutionary development of invertebrates and the use of invertebrate fossils in biostatigraphy and paleoecology. Laboratory.

GEOL 411  Sedimentology and Stratigraphy (4)
Prerequisite: GEOL 122 and GEOL 311.
Study of the origin of sediments and sedimentary rocks for advanced geology majors. Description and interpretation of facies and environments of deposition and classification of clastic and chemical sedimentary rocks is emphasized. Stratigraphic principles, nomenclature and correlation is also treated. Lecture and weekly laboratory.

GEOL 425  Geology of Eastern Washington (4)
Prerequisite: GEOL 122 or permission of the instructor.
Study of the local geology in lectures and a series of field trips. Includes field projects and techniques used during geologic mapping. Observing and recording geologic data in the field and presenting it in terms of a written report and a sketch geologic map of a site-specific area.

GEOL 430  Structural Geology I (4)
Prerequisite: GEOL 411.
Study of the kinematics and mechanics of rock deformation and an introduction to geologic structures. Laboratory introduces the solution of structural geology problems, the map-based interpretation of geologic structures and the creation of geologic cross sections. Weekly laboratory exercises. Designed to be taken in series with GEOL 431.

GEOL 431  Structural Geology II (4)
Prerequisite: GEOL 430.
Continuation of an introduction to geologic structures from GEOL 430 and an exploration of the plate tectonic setting of geologic structures. Introduction to the field study of geologic problems with weekly field trips that emphasize the collection and analysis of geologic field data to solve structural problems. Weekly field trips and laboratory exercises required.

GEOL 455  Geology of the Colorado Plateau (4)
Note: course fee.
Prerequisite: GEOL 100 or permission of the instructor.
This course is a week-long field study of the rocks and landforms of the Colorado Plateau region, specifically in Arches and Canyonlands National Parks. Geologic evolution and structural geology of the region will be discussed and the ancient sedimentary environments of deposition will be emphasized. A field trip will be held during the week of spring break.
GEOL 462 Principles of Geochemistry (5) W
Prerequisites: GEOL 311, 312, 313 or permission of the instructor.

Abundance of elements in the solar system, Origin, chemical evolution and composition of the earth; distribution and migration of chemical elements; differentiation history of the earth into crust, mantle and core. Origin and evolution of the hydrosphere and atmosphere. Chemical processes involved in weathering of rocks, chemical sedimentation and diagenesis.

GEOL 463 Environmental Geochemistry (5) F
Prerequisite: CHEM 152 or permission of the instructor.

Application of principles of geochemistry to environmental problems, including air and water pollution, water-rock interactions, weathering and soil formation. Origin, distribution and transport of inorganic contaminants in air, water, soils, sediments and plants. The behavior of trace elements in near surface environments.

GEOL 466 Isotopic Tracers in the Environment (4) S
Prerequisites: 2.0 in CHEM 153.

This course focuses on the principles and application of radioactive, cosmogenic and stable isotopes as environmental tracers in soil, water, atmosphere and biological materials. Topics include the variations in isotopic composition of natural materials and the processes behind these variations (e.g., fractionation, radioactive decay, mineral dissolution).

GEOL 470 Hydrogeology (4) W
Prerequisites: GEOL 120 or 121, MATH 106, or permission of the instructor.

Relationship between groundwater and geologic materials, emphasizing quantitative analysis and principles governing groundwater flow. Lecture and weekly lab.

GEOL 475 Engineering Geology: Soils (4) W
Prerequisites: GEOL 313, 320, 411 or 470 or permission of the instructor.

Engineering geology of soil and rock is closely related to geotechnical engineering. It includes the properties of soils and rock units related to hydraulic conductivity, compressibility, consolidation, fractures and stress.

GEOL 490 Senior Capstone: Field Camp (10) D
Prerequisites: junior/senior standing and permission of the instructor.

Satisfies: senior capstone university graduation requirement.

This course applies geologic principles to the solution of field problems in the Rocky Mountain fold and thrust belt. This four-week course of study includes geologic mapping, description of stratigraphic relationships, structural analysis, and GPS data collection. Maps, cross sections and a formal report of the field study are required. Location of the camp is Dillon, Montana. Course fee is to be determined.

GEOL 496 Experimental Courses (1–5)

GEOL 497 Workshops, Short Courses, Conferences (1–5)

GEOL 498 Seminars (1–5)

GEOL 499 Directed Study (1–5) FWSU

Note: may be repeated for a total of 15 credits if a different study is undertaken each time.

Prerequisite: permission of the instructor, department chair and college dean.

Seminar in a selected field of geology to suit a student’s need.

GEOL 491 Senior Thesis (4)
Prerequisites: senior standing and permission of the instructor.

Satisfies: senior capstone university graduation requirement.

Directed research on a geological problem and organization of the results for oral and written presentation. End of program assessment will be required. May be used to fulfill the Senior Capstone requirement.

GEOL 495 Practicum (1–5) FWSU
Prerequisite: permission of the instructor, department chair and college dean.

Participation in supervised experiences involving acquisition of data or applications of knowledge to help solve geologic problems. Credits earned in this course are not applicable to degree requirements.

GEOL 490 Senior Capstone: Field Camp (10) D
Prerequisites: junior/senior standing and permission of the instructor.

Satisfies: senior capstone university graduation requirement.

This course applies geologic principles to the solution of field problems in the Rocky Mountain fold and thrust belt. This four-week course of study includes geologic mapping, description of stratigraphic relationships, structural analysis, and GPS data collection. Maps, cross sections and a formal report of the field study are required. Location of the camp is Dillon, Montana. Course fee is to be determined.

GEOL 496 Experimental Courses (1–5)

GEOL 497 Workshops, Short Courses, Conferences (1–5)

GEOL 498 Seminars (1–5)

GEOL 499 Directed Study (1–5) FWSU

Note: may be repeated for a total of 15 credits if a different study is undertaken each time.

Prerequisite: permission of the instructor, department chair and college dean.

Seminar in a selected field of geology to suit a student’s need.

GEOL 491 Senior Thesis (4)
Prerequisites: senior standing and permission of the instructor.

Satisfies: senior capstone university graduation requirement.

Directed research on a geological problem and organization of the results for oral and written presentation. End of program assessment will be required. May be used to fulfill the Senior Capstone requirement.

GEOL 495 Practicum (1–5) FWSU
Prerequisite: permission of the instructor, department chair and college dean.

Participation in supervised experiences involving acquisition of data or applications of knowledge to help solve geologic problems. Credits earned in this course are not applicable to degree requirements.

GEOL 496 Experimental Courses (1–5)

GEOL 497 Workshops, Short Courses, Conferences (1–5)

GEOL 498 Seminars (1–5)

GEOL 499 Directed Study (1–5) FWSU

Note: may be repeated for a total of 15 credits if a different study is undertaken each time.

Prerequisite: permission of the instructor, department chair and college dean.

Seminar in a selected field of geology to suit a student’s need.


**ENVIRONMENTAL SCIENCE MAJOR (111–120 CREDITS)**

Environmental Science is an interdisciplinary field that combines physical, chemical and biological sciences with social, political and economic understanding needed to study the environment and address environmental problems. The Environmental Science program integrates classroom work in biology, chemistry, geology and social sciences (economics and planning) with extensive field, lab and research experience. All students take a core of Environmental Science courses complemented by a concentration in one of the three core sciences (biology, chemistry, and geology). Motivated students have the opportunity to obtain a double major in both Environmental Science and their concentration area. Graduates leave Eastern with the necessary professional and technical skills for employment in the environmental profession or entry into graduate or professional school.

**Major Requirements for Environmental Science**

All Environmental Science students must take a junior year (ENVS 300) and a final senior year environmental seminar (ENVS 400). After declaring environmental science as a major each student should meet with an advisor as soon as possible. Students should start the program with the necessary mathematics background to enter into the calculus or statistics sequence (i.e. MATH 105 or equivalent). It is recommended that students take ENVS 100, BIOL 171–173, CHEM 151–153 and GEOL 120–121 within the first two years. Students must maintain a 2.50 GPA overall to remain in the program.

**Environmental Science Required Courses (81–84 credits)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 171</td>
<td>Biology I</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 172</td>
<td>Biology II</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 173</td>
<td>Biology III</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 270</td>
<td>Biological Investigation</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 440</td>
<td>Ecology</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 151</td>
<td>General Chemistry</td>
<td>5</td>
</tr>
<tr>
<td>CHEM 152</td>
<td>General Chemistry</td>
<td>5</td>
</tr>
<tr>
<td>CHEM 153</td>
<td>General Chemistry</td>
<td>5</td>
</tr>
<tr>
<td>DSCI 245</td>
<td>Data Analysis for Business</td>
<td>4</td>
</tr>
</tbody>
</table>

**Required General Biological Knowledge**

Any one of the following (5 credits)

- BIOL 301 Microbiology (5)
- BIOL 302 Botany (5)
- BIOL 303 Invertebrate Zoology (5)
- BIOL 304 Vertebrate Zoology (5)

**Capstone (5 credits)**

- BIOL 490 Capstone (5)

**Electives (20 credits)**

20 credits of upper division electives with advisor’s consent.

**Required environmental science credits**

- 81–84 credits

**General biological knowledge credits**

- 30 credits

**Minimum total credits for above emphasis**

- 111 credits

**ENVIRONMENTAL CHEMISTRY**

**Required General Chemistry Courses (25 credits)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 304</td>
<td>Quantitative Analysis</td>
<td>5</td>
</tr>
<tr>
<td>CHEM 319</td>
<td>Modern Inorganic Chemistry</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 351</td>
<td>Organic Chemistry</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 352</td>
<td>Organic Chemistry</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 372</td>
<td>Organic Chemistry Lab I</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 491</td>
<td>Senior Thesis</td>
<td>4</td>
</tr>
</tbody>
</table>

**Chemistry Elective, select one (5–6 credits)**

- CHEM 333 Organic Chemistry (5)
- CHEM 373 Organic Chemistry Lab II (3)
- CHEM 480 Biochemistry (5)

**Required Geochimistry Course (5 credits)**

- GEOL 463 Environmental Geochemistry (5)

**Required environmental science credits**

- 81–84 credits

**Minimum total credits for above emphasis**

- 116 credits

**ENVIRONMENTAL GEOLOGY**

**Required Geology Courses (34 credits)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOL 122</td>
<td>Historical Geography</td>
<td>5</td>
</tr>
<tr>
<td>GEOL 311</td>
<td>Earth Materials</td>
<td>4</td>
</tr>
<tr>
<td>GEOL 360</td>
<td>Geologic Hazards</td>
<td>4</td>
</tr>
<tr>
<td>GEOL 411</td>
<td>Sedimentology and Stratigraphy</td>
<td>4</td>
</tr>
<tr>
<td>GEOL 462</td>
<td>Principles of Geochemistry</td>
<td>5</td>
</tr>
<tr>
<td>or GEOL 463</td>
<td>Environmental Geochemistry</td>
<td>5</td>
</tr>
<tr>
<td>GEOL 475</td>
<td>Engineering Geology: Soils</td>
<td>4</td>
</tr>
</tbody>
</table>

**Capstone (4 credits)**

- GEOL 490 Water in the West (4)

**Electives (4 credits)**

4 credits of upper division electives with advisor’s consent.

**Required environmental science credits**

- 81–84 credits

**Minimum total credits for above emphasis**

- 115 credits
MINOR

ENVIRONMENTAL SCIENCE MINOR (34–35 CREDITS)

Required Courses (30 credits)
- BIOL 171 Biology I (5)
- BIOL 172 Biology II (5)
- CHEM 121 Chemistry and its Role in Society (5)
- ENVS 100 Introduction to Environmental Science (5)
- GEOL 120 Physical Geology–The Solid Earth (5)
- GEOL 121 Physical Geology–Surficial Processes (5)

Elective (4–5 credits)
One elective course (4–5) at the 200-level or above in either BIOL, CHEM or GEOL subject to approval by advisor or program director

Total minimum credits for above minor 34 credits

Environmental Science Courses

Terms offered: fall, winter, spring, summer (FWSU). If no terms are indicated, check with the department or EagleNET.

ENVS 100 Introduction to Environmental Science (5)
Prerequisites: CPLA, ENGL and MATH clearance.
Satisfies: GECR for natural sciences, environmental science.
This course is an introductory exploration of environmental science that emphasizes a scientific approach toward understanding contemporary human interaction with the natural environment. The structure, function and interrelationships of terrestrial, aquatic and atmospheric systems are treated through the application of biological, chemical and geological principles. This course includes a weekly laboratory that uses basic quantitative techniques for collecting and analyzing data from environmental systems.

ENVS 300 Environmental Science Junior Seminar (1)
Prerequisite: ENVS 100 and admission to Environmental Science program.
The purpose of this seminar course is to expose students to a variety of potential careers in the environmental sciences.

ENVS 323 GIS Environmental Sciences (3)
Cross-listed: GEOG 323.
Prerequisite: CPLA 101 or CPLA 120.
Introduction to Geographic Information Systems (GIS) with an emphasis on its applications in the environmental sciences. Course includes hands-on GIS work in the lab. This course satisfies an option for the Certificate in GIS.

ENVS 400 Environmental Science Senior Seminar (1)
Prerequisite: ENVS 300 and junior or senior standing.
Through reading current literature, discussion and writing, students integrate knowledge of chemistry, biology and geology with current environmental issues.
**EARTH AND SPACE SCIENCE**

**BAE**

<table>
<thead>
<tr>
<th>Program Advisor</th>
<th>Office</th>
<th>E-mail Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sharen Keattch, Program Advisor</td>
<td>130 Science Bldg.</td>
<td><a href="mailto:geol@ewu.edu">geol@ewu.edu</a> <a href="http://www.ewu.edu/geology">www.ewu.edu/geology</a></td>
</tr>
</tbody>
</table>

**Faculty:** varies.

**UNDERGRADUATE PROGRAMS**

The BAE in Earth and Space Science is for prospective secondary school science teachers. The Earth and Space Science major and minor are interdisciplinary, with required courses from geography, geology, physics, chemistry and biology.

**General Admissions Requirements for Earth and Space Science**

High school students who plan to enter this program are encouraged to take three or four years of both science and mathematics in high school. University students should complete their GECR requirements, particularly in the Natural Sciences, prior to entering the program. Students are encouraged to contact the Earth and Space Science advisor to aid them in selecting these GECR courses.

**General Degree Completion Requirements for Earth and Space Science**

**Grade Requirement for BAE**
- 2.5 cumulative average
- 2.0 in each course

**Required courses in the following programs of study may have prerequisites. Reference the course description section for clarification.**

**BACHELOR OF ARTS IN EDUCATION (BAE)**

*Note:* see the Education Department for prerequisites, core requirements and additional SLOs.

**Student Learning Outcomes—students will:**
- demonstrate an understanding of the principles and concepts of Earth and Space Science and apply supporting knowledge of chemistry, biology and physics;
- demonstrate communication skills necessary to teach Earth and Space Science safely and effectively to secondary school students;
- demonstrate an understanding of various methods of science inquiry;
- plan and implement Earth and Space Science lessons aligned with the national and state standards; construct and use effective assessment strategies.

**EARTH AND SPACE SCIENCE/SECONDARY MAJOR (64–65 CREDITS)**

**SECONDARY EDUCATION CORE (43 CREDITS)**

**Required Courses (60 credits)**
- CHÆM 151 General Chemistry (5)
- GEOG 305 Introduction to Oceanography (5)
- GEOG 410 Geomorphology (5)
- GEOG 314 Weather and Climate (5)
- GEOL 120 Physical Geology--The Solid Earth (5)
- GEOL 121 Physical Geology--Surficial Processes (5)
- GEOL 122 Historical Geology (5)
- GEOL 311 Earth Materials (4)
- GEOL 320 Environmental Geology (4)
- or GEOG 380 Earth Science Teaching Methods (1)
- MATH 106 Precalculus II (5)
- PHYS 131 Introductory Physics I (4)
- PHYS 161 Mechanics Laboratory (1)
- SCED 390 Secondary Science Teaching Methods (1)

**Electives (4–5 credits)**

Students must take 4–5 credits of field-oriented coursework. Select from the list below, or from special field courses in Geography or Geology approved by the Earth and Space Science advisor.

- GEOG 201 Introduction to Field Research (5)
- GEOG/BOLL 312 Fundamentals of Soil Science (4)
- GEOG 315 Surface Hydrology (4)
- GEOG 325 Wetland Science I (4)
- GEOL 455 Colorado Plateau Geology (4)
- GEOL 496 Experimental (Geology Field Trip) (3–5)

**Required credits** 60 credits
**Elective credits** 4–5 credits

**Minimum total credits for above major** 64 credits

*Note:* The above is an interdisciplinary major. See an advisor to determine if courses required by this major may be taken in partial fulfillment of the GECRs.

**MINOR**

**EARTH AND SPACE SCIENCE/SECONDARY MINOR (32 CREDITS)**

This minor satisfies the endorsement for grades 5–12.

**Required Courses**
- GEOG 305 Introduction to Oceanography (5)
- GEOG 314 Weather and Climate (5)
- GEOL 120 Physical Geology--The Solid Earth (5)
- GEOL 121 Physical Geology--Surficial Processes (5)
- GEOL 122 Historical Geology (5)
- GEOL/GEOG 390 Earth Science Teaching Methods (1)
- PHYS 131 Descriptive Astronomy (5)
- SCED 390 Secondary Science Teaching Methods (1)

**Total credits for above minor** 32 credits

**Course Requirements for Teacher Certification/Add-on Endorsements**

**GENERAL SCIENCE/ADD-ON ENDORSEMENT (65 CREDITS)**

(For students who currently possess a Washington State Teaching Certificate.) This add-on satisfies the endorsement and allows teachers to teach any science for grades 5–12.

To improve the marketability of the science teacher, students may wish to complete this option in addition to their BAE in Biology, Chemistry, Earth and Space Science or Physics.

**Required Courses**
- BIOL 171 Biology I (5)
- BIOL 172 Biology II (5)
- BIOL 173 Biology III (5)
- BIOL 390 Biology Teaching Methods (1)
- CHEM 151 General Chemistry (5)
- CHEM 152 General Chemistry (5)
- CHEM 153 General Chemistry (5)
- CHEM 390 Chemistry Methods for the Secondary School (1)
- GEOG 314 Weather and Climate (5)
- GEOL 120 Physical Geology--The Solid Earth (5)
- GEOL 121 Physical Geology--Surficial Processes (5)
- GEOL/GEOG 390 Earth Science Teaching Methods (1)
- PHYS 131 Descriptive Astronomy (5)
- PHYS 132 Introductory Physics II (4)
- PHYS 161 Mechanics Lab (1)
- PHYS 162 Heat and Optics Lab (1)
- PHYS 390 Physics Teaching Methods (1)
- SCED 390 Secondary Science Teaching Methods (1)

**Total credits for above add-on endorsement** 65 credits

**Courses**

See Course Descriptions listed under the participating programs and departments: Biology, Chemistry and Biochemistry, Geography, Geology, Mathematics and Physics.