

# GEOLOGY (GEL)

## College of Letters & Science

### GEL 001 – The Earth (4 units)

*Course Description:* Introduction to the study of the Earth. Earth's physical and chemical structure; internal and surface processes that mold the Earth; geological hazards and resources.

*Learning Activities:* Lecture 3 hour(s), Discussion 1 hour(s).

*Credit Limitation(s):* Not open for credit to students who have taken GEL 050; only 2 credits for students who have taken GEL 002.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Scientific Literacy (SL).

### GEL 002 – Earth System Science (3 units)

*Course Description:* Solid and fluid earth and its place in the solar system. How the solid earth interacts with the atmosphere, hydrosphere, biosphere, and extraterrestrial environment.

*Learning Activities:* Lecture 3 hour(s).

*Credit Limitation(s):* Only 2 units credit for students who have taken GEL 050; only 2 units credit for students who have taken GEL 001.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Scientific Literacy (SL).

### GEL 002G – Earth System Science Discussion (1 unit)

*Course Description:* Small group discussion and preparation of short papers for GEL 002.

*Prerequisite(s):* GEL 002 (can be concurrent); GEL 002 required concurrently.

*Learning Activities:* Discussion 1 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

### GEL 003 – History of Life (3 units)

*Course Description:* The history of life during the three and onehalf billion years from its origin to the present day. Origin of life and processes of evolution; how to visualize and understand living organisms from their fossil remains.

*Prerequisite(s):* GEL 001 recommended.

*Learning Activities:* Lecture 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

### GEL 003G – History of Life: Discussion (1 unit)

*Course Description:* Small group discussion and preparation of short papers for GEL 003. GE credit with concurrent enrollment in GEL 003: WE.

*Prerequisite(s):* GEL 003 (can be concurrent); GEL 003 required concurrently.

*Learning Activities:* Discussion 1 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

### GEL 003L – History of Life Laboratory (1 unit)

*Course Description:* Exercises in understanding fossils as the clues to interpreting ancient life, including their functional morphology, paleoecology, and evolution.

*Prerequisite(s):* GEL 003 (can be concurrent); GEL 003 required concurrently.

*Learning Activities:* Laboratory 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

### GEL 004 – Evolution: Science & World View (3 units)

*Course Description:* Introduction to biological evolution. Emphasis on historical development, major lines of evidence and causes of evolution; relationships between evolution and Earth history; the impact of evolutionary thought on other disciplines.

*Learning Activities:* Lecture 2 hour(s), Discussion 1 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

### GEL 005 – Mass Extinctions: Past & Future (2 units)

*Course Description:* The big five mass extinctions that occurred in deep-time, with comparisons to the extinctions that are occurring currently. Similarities and dissimilarities between the past and modern extinctions.

*Prerequisite(s):* Ability to interpret a table of data.

*Learning Activities:* Lecture 2 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

### GEL 009 – Geology Field Experience (1 unit)

*Course Description:* Exposure to geologic features and earth processes in the field. Experiential instruction in earth-science concepts, spatial visualization, landscape evolution, deep time, critical thinking skills, and integrative scientific themes. One 4-5 day field trip.

*Prerequisite(s):* Consent of instructor; at least one previous GEL class, or concurrent enrollment.

*Learning Activities:* Fieldwork.

*Enrollment Restriction(s):* Pass One open to non-Geology Majors only.

*Repeat Credit:* May be repeated 1 time(s) when field trip destination differs.

*Grade Mode:* Pass/No Pass only.

*General Education:* Science & Engineering (SE).

### GEL 010 – Modern & Ancient Global Environmental Change (3 units)

*Course Description:* Fundamental scientific concepts underlying issues such as global warming, pollution, and the future of nonsustainable resources presented in the context of anthropogenic processes as well as natural forcing of paleoenvironmental change throughout Earth's history.

*Learning Activities:* Lecture 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Scientific Literacy (SL); Visual Literacy (VL).

### GEL 012 – Evolution & Paleobiology of Dinosaurs (2 units)

*Course Description:* Introduction to evolutionary biology, paleobiology, ecology and paleoecology, using dinosaurs as case studies.

*Learning Activities:* Lecture 2 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

### GEL 016 – The Oceans (3 units)

*Course Description:* Introductory survey of the marine environment. Oceanic physical phenomena, chemical constituents and chemistry of water, geological history, the seas biota and human utilization of marine resources.

*Learning Activities:* Lecture 3 hour(s).

*Credit Limitation(s):* Not open for credit to students who have taken GEL 116.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Scientific Literacy (SL).

### **GEL 016G – The Oceans: Discussion (2 units)**

*Course Description:* Scientific method applied to discovery of the processes, biota and history of the oceans. Group discussion and preparation of term paper.

*Prerequisite(s):* GEL 016 (can be concurrent) or GEL 016V (can be concurrent).

*Learning Activities:* Discussion/Laboratory 2 hour(s), Term Paper/Discussion 4 hour(s).

*Credit Limitation(s):* Not open for credit to students who have taken GEL 116G.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

### **GEL 016V – The Oceans (3 units)**

*Course Description:* Introductory survey of the marine environment. Oceanic physical phenomena, chemical constituents and chemistry of water, geological history, the seas biota and human utilization of marine resources.

*Learning Activities:* Web Virtual Lecture 3 hour(s).

*Credit Limitation(s):* Not open for credit to students who have taken GEL 116.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Scientific Literacy (SL).

### **GEL 017 – Earthquakes & Other Earth Hazards (2 units)**

*Course Description:* Impact of earthquakes, tsunamis, volcanoes, landslides, and floods on humans, structures, and the environment. Discussion of the causes and effects of disasters and catastrophes, and on prediction, preparation, and mitigation of natural hazards.

*Learning Activities:* Lecture 2 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Scientific Literacy (SL).

### **GEL 018 – Energy & the Environment (3 units)**

*Course Description:* Conventional and alternative energy resources and their environmental impacts. Basic principles, historical development, current advantages and disadvantages, future prospects. Oil, natural gas, coal, nuclear, wind, geothermal, water, tidal, solar, hydrogen, and other sources of energy for the 21st century.

*Learning Activities:* Lecture 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

### **GEL 018V – Energy & the Environment (3 units)**

*Course Description:* Conventional and alternative energy resources and their environmental impacts. Basic principles, historical development, current advantages and disadvantages, future prospects. Oil, natural gas, coal, nuclear, wind, geothermal, water, tidal, solar, hydrogen, and other sources of energy for the 21st century.

*Learning Activities:* Web Virtual Lecture 1.50 hour(s), Web Electronic Discussion 1.50 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

### **GEL 020 – Geology of California (2 units)**

*Course Description:* The geologic history of California, the origin of rocks and the environments in which they were formed, the structure of the rocks and the interpretation of their structural history, mineral resources, and appreciation of the California landscape. Offered in alternate years.

*Learning Activities:* Lecture 2 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Scientific Literacy (SL); Visual Literacy (VL).

### **GEL 025 – Geology of National Parks (3 units)**

This version has ended; see updated course, below.

*Course Description:* Appreciation of the geologic framework underlying the inherent beauty of U.S. National Parks. Relationship of individual parks to geologic processes such as mountain building, volcanism, stream erosion, glacial action and landscape evolution.

*Learning Activities:* Lecture 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Scientific Literacy (SL).

### **GEL 025 – Geology of National Parks (3 units)**

*Course Description:* Appreciation of the geologic framework underlying the inherent beauty of U.S. National Parks. Relationship of individual parks to geologic processes such as mountain building, volcanism, stream erosion, glacial action and landscape evolution.

*Learning Activities:* Lecture 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

This course version is effective from, and including: Spring Quarter 2025.

### **GEL 025V – Geology of National Parks (3 units)**

*Course Description:* Appreciation of the geologic framework underlying the inherent beauty of U.S. National Parks. Relationship of individual parks to geologic processes such as mountain building, volcanism, stream erosion, glacial action and landscape evolution.

*Learning Activities:* Web Virtual Lecture 1 hour(s), Web Electronic Discussion 2 hour(s).

*Credit Limitation(s):* No credit for students who have completed GEL 025.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

### **GEL 028 – Astrobiology (3 units)**

*Course Description:* Origin, evolution and distribution of life in our solar system and the Universe. Detecting habitable worlds, Drake equations, necessities and raw materials for life, philosophical implications of the search for life elsewhere.

*Learning Activities:* Lecture 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Scientific Literacy (SL).

**GEL 030 – Fractals, Chaos & Complexity (3 units)**

This version has ended; see updated course, below.

*Course Description:* Modern ideas about the unifying ideas of fractal geometry, chaos and complexity. Basic theory and applications with examples from physics, earth sciences, mathematics, population dynamics, ecology, history, economics, biology, computer science, art and architecture. Offered in alternate years.

*Prerequisite(s):* MAT 016A or MAT 017A or MAT 021A.

*Learning Activities:* Lecture/Discussion 3 hour(s).

*Cross Listing:* PHY 030.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Quantitative Literacy (QL).

**GEL 030 – Fractals, Chaos & Complexity (3 units)**

*Course Description:* Modern ideas about the unifying ideas of fractal geometry, chaos and complexity. Basic theory and applications with examples from physics, earth sciences, mathematics, population dynamics, ecology, history, economics, biology, computer science, art and architecture. Offered in alternate years.

*Prerequisite(s):* MAT 016A or MAT 017A or MAT 019A or MAT 021A.

*Learning Activities:* Lecture/Discussion 3 hour(s).

*Cross Listing:* PHY 030.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Quantitative Literacy (QL).

This course version is effective from, and including: Fall Quarter 2024.

**GEL 032 – Volcanoes (3 units)**

*Course Description:* Role of eruptions, and eruptive products of volcanoes in shaping the planet's surface, influencing its environment, and providing essential human resources.

*Learning Activities:* Lecture 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

**GEL 035 – Rivers (3 units)**

*Course Description:* Introduction to geomorphology, climate and geology of rivers and watersheds, with case examples from California. Assessment of impacts of logging, agriculture, mining, urbanization and water supply on river processes. Optional river field trips.

*Learning Activities:* Lecture 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Scientific Literacy (SL).

**GEL 036 – The Solar System (4 units)**

This version has ended; see updated course, below.

*Course Description:* Nature of the sun, moon, and planets as determined by recent manned and unmanned exploration of the solar system. Comparison of terrestrial, lunar, and planetary geological processes. Search for life on other planets. Origin and evolution of the solar system. (Former course GEL 113 & GEL 113G.)

*Learning Activities:* Lecture 3 hour(s), Discussion 1 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Visual Literacy (VL); Writing Experience (WE).

**GEL 036 – The Solar System (4 units)**

*Course Description:* Nature of the sun, moon, and planets as determined by recent manned and unmanned exploration of the solar system. Comparison of terrestrial, lunar, and planetary geological processes. Search for life on other planets. Origin and evolution of the solar system. (Former course GEL 113 & GEL 113G.)

*Learning Activities:* Lecture 3 hour(s), Discussion 1 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Visual Literacy (VL).

This course version is effective from, and including: Spring Quarter 2025.

**GEL 050 – Physical Geology (3 units)**

*Course Description:* The Earth, its materials, its internal and external processes, its development through time by sea-floor spreading and global plate tectonics.

*Prerequisite(s):* High school physics and chemistry.

*Learning Activities:* Lecture 3 hour(s).

*Credit Limitation(s):* Students with credit for GEL 001 or the equivalent may receive only 2 units for GEL 050.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Scientific Literacy (SL).

**GEL 050L – Physical Geology Laboratory (2 units)**

*Course Description:* Introduction to classification and recognition of minerals and rocks and to interpretation of topographic and geologic maps and aerial photographs.

*Prerequisite(s):* GEL 050 (can be concurrent).

*Learning Activities:* Laboratory 6 hour(s).

*Credit Limitation(s):* Students with credit for GEL 001L or the equivalent may receive only 1 unit for GEL 050L.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

**GEL 053 – Introduction to Geobiology (3 units)**

*Course Description:* Introduction to interactions between Earth and life with an emphasis on how metabolism, cellular processes, evolution and ecology emerged within natural environments and have changed Earth's surface.

*Prerequisite(s):* GEL 001 or GEL 002 or GEL 050.

*Learning Activities:* Lecture 2 hour(s), Discussion 1 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

**GEL 055 – Introduction to Geochemistry (3 units)**

*Course Description:* Introduction to key geochemical principles in Earth & Planetary Sciences; chemical bonding, geochemical affinity of elements, redox & acid base equilibria in geological systems, radioactive decay, isotopic fractionation and paleoclimate records.

*Prerequisite(s):* (GEL 001 or GEL 002 or GEL 050); (CHE 002A or CHE 002AH); (CHE 002B or CHE 002BH).

*Learning Activities:* Lecture 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

**GEL 056 – Introduction to Geophysics (4 units)**

*Course Description:* Introduction to geophysical topics essential to all aspects of Earth and planetary sciences: theory of plate tectonics, gravitational field of planets, diffusion, rheology, seismology, and earthquakes.

*Prerequisite(s):* (GEL 001 or GEL 050); (PHY 007A or PHY 009A); (PHY 007B or PHY 009B).

*Learning Activities:* Lecture/Discussion 3 hour(s), Laboratory 2 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

**GEL 060 – Earth Materials: Introduction (4 units)**

This version has ended; see updated course, below.

*Course Description:* Physical and chemical properties of Earth materials; structure, chemical composition, and identification of rock-forming minerals; mineral-rock associations, and their origin from silicate liquids, aqueous fluids, and solid state transformations.

*Prerequisite(s):* (CHE 002A or CHE 002AH or CHE 004A); (CHE 002B or CHE 002BH or CHE 004B); (MAT 016A or MAT 017A or MAT 019A or MAT 021A); (GEL 001 or GEL 050); GEL 050L.

*Learning Activities:* Lecture 3 hour(s), Laboratory 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

**GEL 060 – Earth Materials: Introduction (4 units)**

*Course Description:* Physical and chemical properties of Earth materials; structure, chemical composition, and identification of rock-forming minerals; mineral-rock associations, and their origin from silicate liquids, aqueous fluids, and solid state transformations.

*Prerequisite(s):* (CHE 002A or CHE 002AH or CHE 004A); (CHE 002B or CHE 002BH or CHE 004B); (MAT 017A or MAT 019A or MAT 021A); (GEL 001 or GEL 050); GEL 050L.

*Learning Activities:* Lecture 3 hour(s), Laboratory 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

This course version is effective from, and including: Spring Quarter 2025.

**GEL 062 – Optical Mineralogy (2 units)**

*Course Description:* Optical properties of inorganic crystals; techniques of mineral identification using the polarizing microscope; strategies for studying rocks in thin section.

*Prerequisite(s):* GEL 060 (can be concurrent).

*Learning Activities:* Lecture 1 hour(s), Laboratory 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

**GEL 081 – Learning in Science & Mathematics (2 units)**

*Course Description:* Exploration of how students learn and develop understanding in science and mathematics classrooms. Introduction to case studies and interview techniques and their use in K-6 classrooms to illuminate factors that affect student learning.

*Learning Activities:* Lecture/Discussion 2 hour(s), Fieldwork 2 hour(s).

*Enrollment Restriction(s):* Limited to 26 students per section.

*Cross Listing:* EDU 081.

*Grade Mode:* Pass/No Pass only.

*General Education:* Social Sciences (SS); Visual Literacy (VL); Writing Experience (WE).

**GEL 092 – Internship (1-12 units)**

*Course Description:* Work-learn experience on and off campus in all subject areas offered by the department. Internships supervised by a member of the faculty.

*Prerequisite(s):* Consent of instructor; lower division standing.

*Learning Activities:* Internship 3-36 hour(s).

*Repeat Credit:* May be repeated 12 unit(s).

*Grade Mode:* Pass/No Pass only.

*General Education:* Science & Engineering (SE).

**GEL 098 – Directed Group Study (1-5 units)**

*Course Description:* Directed group study.

*Prerequisite(s):* Consent of instructor.

*Learning Activities:* Variable 3-15 hour(s).

*Repeat Credit:* May be repeated 3 time(s) when content differs.

*Grade Mode:* Pass/No Pass only.

*General Education:* Science & Engineering (SE).

**GEL 099 – Special Study for Undergraduates (1-5 units)**

*Course Description:* Special study for undergraduates.

*Prerequisite(s):* Consent of instructor; lower division standing.

*Learning Activities:* Variable.

*Grade Mode:* Pass/No Pass only.

*General Education:* Science & Engineering (SE).

**GEL 101 – Structural Geology (3 units)**

*Course Description:* Study of processes and products of rock deformation. Introduction to structural geology through a survey of the features and geometries of faults and folds, techniques of strain analysis, and continuum mechanics of rock deformation.

*Prerequisite(s):* GEL 050; GEL 050L; (PHY 007A or PHY 009A); (MAT 016A or MAT 017A or MAT 019A or MAT 021A); consent of instructor.

*Learning Activities:* Lecture 3 hour(s).

*Enrollment Restriction(s):* Limited to 35 students.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

**GEL 101L – Structural Geology Lab (2 units)**

*Course Description:* Laboratory study of the processes and products of rock deformation. Introduction to the practice of structural geology through observations and analysis of rock deformation, including field measurement techniques and geologic mapping.

*Prerequisite(s):* GEL 050; GEL 050L; (PHY 007A or PHY 009A); GEL 101 (can be concurrent); consent of instructor.

*Learning Activities:* Laboratory 6 hour(s), Fieldwork 2 hour(s).

*Enrollment Restriction(s):* Limited to 15 students per session.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Visual Literacy (VL).



**GEL 103 – Field Geology (4 units)**

*Course Description:* Field mapping projects and writing geological reports. Weekly classroom meetings devoted to preparation of maps, cross sections, stratigraphic sections, rock descriptions, and reports. Seven-eight days for field trips will occur on weekends during the quarter.

*Prerequisite(s):* GEL 101; GEL 101L.

*Learning Activities:* Lecture 1 hour(s), Fieldwork 6 hour(s), Term Paper.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Scientific Literacy (SL); Visual Literacy (VL); Writing Experience (WE).

**GEL 105 – Earth Materials: Igneous Rocks (4 units)**

*Course Description:* Origin and occurrence of igneous rocks. Laboratory exercises emphasize the study of these rocks in hand specimen and thin section.

*Prerequisite(s):* GEL 060; (MAT 016A or MAT 017A or MAT 019A or MAT 021A); CHE 002B (can be concurrent).

*Learning Activities:* Lecture 2 hour(s), Laboratory 6 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Writing Experience (WE).

**GEL 106 – Earth Materials: Metamorphic Rocks (4 units)**

*Course Description:* Physical and chemical properties of metamorphic rocks; interpretation of metamorphic environments. Laboratory exercises emphasize the study of these rocks in hand specimen and thin section.

*Prerequisite(s):* GEL 105.

*Learning Activities:* Lecture 2 hour(s), Laboratory 6 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

**GEL 107 – Earth History: Paleobiology (3 units)**

*Course Description:* Evolution and ecological structure of the biosphere from the origin of life to the present.

*Prerequisite(s):* GEL 003 or GEL 053 or BIS 002A or BIS 002B.

*Learning Activities:* Lecture 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

**GEL 107L – Earth History: Paleobiology Laboratory (2 units)**

*Course Description:* Exercises in determining the ecological functions and evolution of individuals, populations, and communities of fossil organisms in field and laboratory.

*Prerequisite(s):* GEL 107 (can be concurrent).

*Learning Activities:* Laboratory 6 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

**GEL 108 – Earth History: Paleoclimates (3 units)**

*Course Description:* Geological and environmental factors controlling climate change, the greenhouse effect with a detailed analysis of the history of Earth's climate fluctuations over the last 600 million years. Past and present climate records are used to examine potential future climatic scenarios.

*Prerequisite(s):* (GEL 001 or GEL 050 or GEL 116N or ESP 116N); CHE 002A; consent of instructor.

*Learning Activities:* Lecture 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Scientific Literacy (SL); Writing Experience (WE).

**GEL 109 – Earth History: Sediments & Strata (3 units)**

*Course Description:* Sediment formation, transport, and deposition. Interpretations of sedimentary processes across landscapes and through time in the context of environmental and geological problems. Reconstruction of ancient environmental change from sedimentary rocks.

*Prerequisite(s):* GEL 001 or GEL 050.

*Learning Activities:* Lecture 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

**GEL 109L – Earth History: Sediments & Strata Laboratory (2 units)**

*Course Description:* Methods of stratigraphic and sedimentologic analysis of modern and ancient sediments. Identification of major sediment and sedimentary rock types. Outcrop and subsurface analysis of sedimentary basins. GE credit with concurrent enrollment in GEL 109. Includes four one-day field trips.

*Prerequisite(s):* GEL 050L; GEL 109 (can be concurrent).

*Learning Activities:* Laboratory 6 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Writing Experience (WE).

**GEL 110A – Summer Field Geology: Structures & Neotectonics (4 units)**

*Course Description:* Advanced application of geologic field methods to the study of deformed rocks and their interpretation in terms of tectonic processes. Includes development and interpretation of geologic maps, cross sections and stratigraphic sections. Six days/week for three weeks in an off-campus location.

*Prerequisite(s):* GEL 103; GEL 060 recommended.

*Learning Activities:* Fieldwork 40 hour(s).

*Credit Limitation(s):* Not open for credit to students who have taken GEL 110.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Scientific Literacy (SL); Visual Literacy (VL); Writing Experience (WE).

**GEL 110B – Summer Field Geology: Volcanology (4 units)**

*Course Description:* Advanced application of geologic field methods to the study of volcanic and plutonic rocks and their interpretation in terms of igneous processes. Includes development and interpretation of geologic maps, cross sections, stratigraphic sections, and outcrop scale observations. Six days/week for three weeks in an off-campus location.

*Prerequisite(s):* GEL 105; GEL 109.

*Learning Activities:* Fieldwork 40 hour(s).

*Credit Limitation(s):* Not open for credit to students who have taken GEL 110.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Scientific Literacy (SL); Visual Literacy (VL); Writing Experience (WE).

### **GEL 110C – Summer Field Geology: Special Projects (4 units)**

*Course Description:* Advanced application of geologic field methods to a special project location and the interpretation of field observations in terms of its geologic processes and geologic history. Variable field location and specific activities. Six days/week for three weeks in an off-campus location.

*Prerequisite(s):* Consent of instructor.

*Learning Activities:* Fieldwork 40 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Scientific Literacy (SL); Writing Experience (WE).

### **GEL 115 – Earth Science, History, & People (4 units)**

Starting Spring Quarter 2025, this course is no longer offered.

*Course Description:* Study of interplay between the Earth and its human inhabitants through history, including consideration of acute events such as earthquakes and eruptions as well as the geology of resources, topography, and water.

*Prerequisite(s):* GEL 001 or GEL 050.

*Learning Activities:* Lecture 3 hour(s), Discussion 1 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Oral Skills (OL); Writing Experience (WE).

### **GEL 116N – Oceanography (3 units)**

*Course Description:* Advanced oceanographic topics: Chemical, physical, geological, and biological processes; research methods and data analysis; marine resources, anthropogenic impacts, and climate change; integrated earth/ocean/atmosphere systems; weekly lab and one weekend field trip.

*Prerequisite(s):* GEL 001 or GEL 002 or GEL 016 or GEL 016V or GEL 050.

*Learning Activities:* Lecture 2 hour(s), Laboratory 3 hour(s), Fieldwork.

*Cross Listing:* ESP 116N.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Scientific Literacy (SL).

### **GEL 120 – Origins: From the Big Bang to Today (3 units)**

*Course Description:* Long-term and large-scale perspectives on the origins of the universe, stars and planets, life, human evolution, the rise of civilization and the modern world. Multi-disciplinary approach to "Big History" involving cosmology, astronomy, geology, climatology, biology, anthropology, archeology and traditional history.

*Learning Activities:* Lecture 3 hour(s).

*Enrollment Restriction(s):* Limited enrollment.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

### **GEL 130 – Non-Renewable Natural Resources (3 units)**

*Course Description:* Origin, occurrence, and distribution of non-renewable resources, including metallic, nonmetallic, and energy-producing materials. Problems of discovery, production, and management. Estimations and limitations of reserves, and their sociological, political, and economic effects.

*Prerequisite(s):* GEL 001 or GEL 050.

*Learning Activities:* Lecture 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

### **GEL 131 – Risk: Natural Hazards & Related Phenomena (3 units)**

*Course Description:* Risk, prediction, prevention and response for earthquakes, volcanic eruptions, landslides, floods, storms, fires, impacts, global warming.

*Learning Activities:* Lecture 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Scientific Literacy (SL).

### **GEL 132 – Introductory Inorganic Geochemistry (3 units)**

*Course Description:* Nucleosynthesis of chemical elements, physical and chemical properties of elements, ionic substitution, elemental partition, distribution and transport among planetary materials, basic thermodynamics and phase diagrams, isotopic geochronometers, stable isotope fractionation, mixing and dilution, advection and diffusion, geochemical cycles.

*Prerequisite(s):* GEL 060 (can be concurrent); CHE 002B.

*Learning Activities:* Lecture 3 hour(s).

*Grade Mode:* Letter.

### **GEL 133 – Environmental Geochemistry (3 units)**

*Course Description:* Introduction to Earth surface processes with a focus on topics of current environmental interest such as nuclear power and waste disposal, acid mine drainage, carbon sequestration, history of polar ice sheets and sea level change.

*Prerequisite(s):* CHE 002A; CHE 002B.

*Learning Activities:* Lecture 3 hour(s).

*Grade Mode:* Letter.

### **GEL 134 – Environmental Geology & Land Use Planning (3 units)**

*Course Description:* Geologic aspects of land use and development planning. Geologic problems concerning volcanic and earthquake hazards, land stability, floods, erosion, coastal hazards, non-renewable resource extraction, waste disposal, water resources.

*Prerequisite(s):* GEL 001 or GEL 050; consent of instructor.; one course in Geology (GEL).

*Learning Activities:* Lecture 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Writing Experience (WE).

### **GEL 136 – Ecogeomorphology of Rivers & Streams (5 units)**

*Course Description:* Integrative multidisciplinary field analysis of streams. Class project examines hydrology, geomorphology, water quality and aquatic and riparian ecology of degraded and pristine stream systems. Includes cooperative two-week field survey in remote wilderness settings with students from diverse scientific backgrounds.

*Prerequisite(s):* Consent of instructor. Upper division or graduate standing in any physical science, biological science, or engineering.

*Learning Activities:* Lecture 1 hour(s), Discussion/Laboratory 2 hour(s), Fieldwork, Term Paper.

*Enrollment Restriction(s):* Restricted to advanced students in the physical sciences, biological sciences, or engineering.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Writing Experience (WE).

**GEL 138 – Introductory Volcanology (4 units)**

*Course Description:* Principles of physical and chemical volcanology. Taught in a volcanically active setting (e.g., Hawaii) with a strong field component.

*Prerequisite(s):* GEL 060; GEL 109; consent of instructor.

*Learning Activities:* Lecture 2 hour(s), Fieldwork 6 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

**GEL 139 – Rivers: Form, Function & Management (4 units)**

*Course Description:* Analysis of river form and processes, emphasis on fluvial geomorphology, and river and stream restoration; case studies to illustrate concepts and applications. Two weekend field trips required. Offered irregularly.

*Prerequisite(s):* GEL 050 or GEL 050L; MAT 016B or MAT 017B or MAT 019B or MAT 021B recommended.

*Learning Activities:* Lecture 3 hour(s), Fieldwork 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

**GEL 140 – Introduction to Process Geomorphology (4 units)**

*Course Description:* Quantitative description and interpretation of landscapes with emphasis on the relationships between physical processes, mass conservation, and landform evolution. Topics covered include physical & chemical weathering, hillslopes, debris flows, fluvial systems, alluvial fans, pedogenesis, eolian transport, glaciation and Quaternary geochronology.

*Prerequisite(s):* (GEL 001 or GEL 050); (MAT 016B or MAT 017B or MAT 019B or MAT 021B).

*Learning Activities:* Lecture 3 hour(s), Laboratory 3 hour(s).

*Grade Mode:* Letter.

**GEL 141 – Evolutionary History of Vertebrates (3 units)**

*Course Description:* Evolutionary history of vertebrates; fossil record and phylogeny; timing of major evolutionary events; appearance of major vertebrate groups; physical constraints in vertebrate evolution; paleobiogeography of vertebrates; effect of continental movement on vertebrate evolution; dinosaurs and other strange vertebrates. Offered in alternate years.

*Prerequisite(s):* GEL 003 or GEL 053 or BIS 002A.

*Learning Activities:* Lecture 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

**GEL 141L – Evolutionary History of Vertebrates Laboratory (1 unit)**

*Course Description:* Augments lecture GEL 141 through handling of specimens enabling in-person examination of three dimensional features observed in vertebrate skeletons, both fossil and living. Offered in alternate years.

*Prerequisite(s):* GEL 141 (can be concurrent).

*Learning Activities:* Laboratory 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

**GEL 142 – Basin Analysis (3 units)**

*Course Description:* Analysis of sedimentary basins from initiation to maturity, including controls on sedimentary fill, subsidence analysis, sequence stratigraphy, core logs, and applications to petroleum exploration and hydrology. One two-day field trip. Offered irregularly.

*Prerequisite(s):* GEL 050; GEL 050L; GEL 109.

*Learning Activities:* Lecture 2 hour(s), Laboratory 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Visual Literacy (VL).

**GEL 143 – Advanced Igneous Petrology (5 units)**

*Course Description:* Physical and chemical properties of magmatic environments and processes of igneous rock formation. Laboratory study of representative igneous rocks. Offered irregularly.

*Prerequisite(s):* GEL 105; (MAT 016C or MAT 017C or MAT 019C or MAT 021C); (CHE 002C or GEL 055).

*Learning Activities:* Lecture 3 hour(s), Laboratory 6 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

**GEL 144 – Historical Ecology (3 units)**

*Course Description:* Ancient ecosystems and the factors that caused them to change. Species, expansion, evolution of new modes of life, geologically induced variations in resource supply, and extinction provide historical perspective on the biosphere of future.

*Prerequisite(s):* Upper division course in environmental science or ecology, or an introductory course in paleobiology.

*Learning Activities:* Lecture 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Writing Experience (WE).

**GEL 145 – Advanced Metamorphic Petrology (5 units)**

*Course Description:* Metamorphic processes and the origin of metamorphic rocks. Laboratory study of representative rock suites. Offered irregularly.

*Prerequisite(s):* GEL 106; (HYD 134 or CHE 002C or GEL 055); (MAT 016C or MAT 017C or MAT 019C or MAT 021C).

*Learning Activities:* Lecture 3 hour(s), Laboratory 6 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

**GEL 146 – Radiogenic Isotope Geochemistry & Cosmochemistry (3 units)**

*Course Description:* Basic principles of nuclear chemistry and physics applied to geology to determine the ages of terrestrial rocks, meteorites, archeological objects, age of the Earth, to trace geological/environmental processes, and explain formation of the chemical elements in the Universe. Offered irregularly.

*Prerequisite(s):* (CHE 002C or GEL 055); (PHY 007C or PHY 009C or GEL 056); (MAT 016C or MAT 017C or MAT 019C or MAT 021C).

*Learning Activities:* Lecture 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Quantitative Literacy (QL).

**GEL 147 – Geology of Ore Deposits (4 units)**

*Course Description:* Tectonic, lithologic and geochemical setting of major metallic ore deposit types emphasizing ore deposit genesis, water/rock interaction and the environmental effects of mining. Offered irregularly.

*Prerequisite(s):* (CHE 002C or GEL 055 or HYD 134); GEL 060; GEL 105.

*Learning Activities:* Lecture 3 hour(s), Laboratory 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

**GEL 148 – Stable Isotopes & Geochemical Tracers (3 units)**

*Course Description:* Use of oxygen and hydrogen isotopes in defining hydrologic processes; carbon, nitrogen, and sulfur isotopes as indicators of exchange between the lithosphere, hydrosphere, atmosphere and biosphere. Radiogenic, cosmogenic, and noble gas isotope tracers. Offered irregularly.

*Prerequisite(s):* (CHE 002C or GEL 055 or HYD 134); GEL 050; GEL 050L; GEL 060.

*Learning Activities:* Lecture 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Quantitative Literacy (QL).

**GEL 149 – Geothermal Systems (3 units)**

*Course Description:* Geology, geochemistry, and geophysics of geothermal systems, including electrical power generation and direct use applications. Includes one day field trip on a weekend during the quarter. Offered irregularly.

*Prerequisite(s):* GEL 050; GEL 050L; CHE 002B.

*Learning Activities:* Lecture 3 hour(s), Fieldwork.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

**GEL 150A – Physical & Chemical Oceanography (4 units)**

*Course Description:* Physical and chemical properties of seawater, fluid dynamics, air-sea interaction, currents, waves, tides, mixing, major oceanic geochemical cycles.

*Prerequisite(s):* (ESP 116N or GEL 116N); (PHY 007B or PHY 009B); (MAT 016C or MAT 017C or MAT 019C or MAT 021C); (CHE 002C or GEL 055); consent of instructor.

*Learning Activities:* Lecture 3 hour(s), Discussion 1 hour(s).

*Cross Listing:* ESP 150A.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Quantitative Literacy (QL).

**GEL 150B – Geological Oceanography (3 units)**

*Course Description:* Introduction to the origin and geologic evolution of ocean basins. Composition and structure of oceanic crust; marine volcanism; and deposition of marine sediments. Interpretation of geologic history of the ocean floor in terms of sea-floor spreading theory.

*Prerequisite(s):* GEL 050 or (GEL 116N or ESP 116N).

*Learning Activities:* Lecture 3 hour(s).

*Cross Listing:* ESP 150B.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

**GEL 150C – Biological Oceanography (4 units)**

*Course Description:* Ecology of major marine habitats, including intertidal, shelf benthic, deep-sea and plankton communities. Existing knowledge and contemporary issues in research. Segment devoted to human use. One weekend field trip required.

*Prerequisite(s):* BIS 002A; consent of instructor; a course in general ecology.

*Learning Activities:* Lecture 3 hour(s), Discussion 1 hour(s), Fieldwork.

*Cross Listing:* ESP 150C.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Scientific Literacy (SL).

**GEL 152 – Paleobiology of Protista (4 units)**

*Course Description:* Morphology, systematics, evolution, and ecology of single-celled organisms that are preserved in the fossil record. Offered irregularly.

*Prerequisite(s):* GEL 107 or BIS 002A; consent of instructor.

*Learning Activities:* Lecture 2 hour(s), Laboratory 6 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

**GEL 156 – Hydrogeology & Contaminant Transport (5 units)**

*Course Description:* Physical and chemical processes affecting groundwater flow and contaminant transport, with emphasis on realistic hydrogeologic systems. Groundwater geology and chemistry. Fundamentals of groundwater flow and transport analysis. Laboratory includes field pumping test and work with physical and computer models.

*Prerequisite(s):* HYD 144 or ECI 144; or the equivalent.

*Learning Activities:* Lecture 3 hour(s), Laboratory 3 hour(s), Term Paper 1 hour(s).

*Cross Listing:* HYD 146.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

**GEL 160 – Geological Data Analysis (3 units)**

*Course Description:* Introduction to quantitative methods in analyzing geological data including basic principles of statistics and probability, error analysis, hypothesis testing, inverse theory, time series analysis and directional data analyses.

*Prerequisite(s):* (MAT 016A (can be concurrent) or MAT 017A (can be concurrent) or MAT 019A { can be concurrent } or MAT 021A (can be concurrent)); GEL 056; or prior introductory level programming in Python, Matlab, or R.

*Learning Activities:* Lecture/Discussion 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Quantitative Literacy (QL).



**GEL 161 – Geophysical Field Methods (3 units)**

*Course Description:* Geophysical methods applied to determining subsurface structure in tectonics, hydrogeology, geotechnical engineering, and hydrocarbon & mineral exploration. Theory, survey design & interpretation of gravity, electrical resistivity, electromagnetic, reflection & refraction seismology, and ground-penetrating radar measurements.

*Prerequisite(s):* (GEL 001 C- or better or GEL 050 C- or better); (MAT 016C C- or better or MAT 017C C- or better or MAT 019C C- or better or MAT 021C C- or better); (PHY 007A C- or better or PHY 009A C- or better); (PHY 007B C- or better or PHY 009B C- or better); (GEL 056 C- or better or PHY 007C C- or better or PHY 009C C- or better).

*Learning Activities:* Lecture/Discussion 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Quantitative Literacy (QL); Science & Engineering (SE); Scientific Literacy (SL).

**GEL 162 – Geophysics of the Solid Earth (3 units)**

*Course Description:* Theory and use of physics in the study of the solid earth. Gravity, magnetism, paleomagnetism, and heat flow. Application to the interpretation of the regional and large-scale structure of the earth and to plate tectonics. Offered irregularly.

*Prerequisite(s):* (MAT 016C or MAT 017C or MAT 019C or MAT 021C); (GEL 056 or PHY 007C or PHY 009C).

*Learning Activities:* Lecture 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Quantitative Literacy (QL).

**GEL 163 – Planetary Geology & Geophysics (3 units)**

*Course Description:* Principles of planetary science. Planetary dynamics, including orbital mechanics, tidal interactions and ring dynamics. Theory of planetary interiors, gravitational fields, rotational dynamics. Physics of planetary atmospheres. Geological processes, landforms and their modification. Methods of analysis from Earth-based observations and spacecraft.

*Prerequisite(s):* (GEL 001 or GEL 002 or GEL 028 or GEL 036 or GEL 050 or AST 010G or AST 010L or AST 010S or AST 025); (MAT 016A or MAT 017A or MAT 019A or MAT 021A); (PHY 007A or PHY 009A); (PHY 007B or PHY 009B); (GEL 056 or PHY 007C or PHY 009C).

*Learning Activities:* Lecture 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Quantitative Literacy (QL).

**GEL 175 – Advanced Field Geology (3 units)**

*Course Description:* Advanced field studies of selected geologic terrains, interpretation and discussion of field observations. Offered irregularly.

*Prerequisite(s):* Consent of instructor.

*Learning Activities:* Discussion 3 hour(s), Fieldwork 6 hour(s).

*Repeat Credit:* May be repeated 2 time(s) when instructors differs.

*Grade Mode:* Pass/No Pass only.

*General Education:* Science & Engineering (SE).

**GEL 181 – Teaching in Science & Mathematics (2 units)**

*Course Description:* Exploration of effective teaching practices based on examination of how middle school students learn math and science. Selected readings, discussion and field experience in middle school classrooms.

*Prerequisite(s):* Consent of instructor; major in mathematics, science, or engineering; or completion of a one-year sequence of science or calculus.

*Learning Activities:* Lecture/Discussion 2 hour(s), Fieldwork 2 hour(s).

*Enrollment Restriction(s):* Limited to 40 students per section.

*Cross Listing:* EDU 181.

*Grade Mode:* Pass/No Pass only.

*General Education:* Social Sciences (SS); Writing Experience (WE).

**GEL 182 – Field Studies in Marine Geochemistry (2-8 units)**

*Course Description:* Marine geochemistry with the opportunity of going to sea or into the field on land. Techniques of sea-floor mapping using bottom photography, marine geochemical sampling, and method of data reduction and sample analysis. Analysis of data/samples collected.

Offered irregularly.

*Prerequisite(s):* Consent of instructor.

*Learning Activities:* Lecture 3 hour(s), Laboratory 1-3 hour(s), Fieldwork 6-40 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

**GEL 183 – Teaching High School Mathematics & Science (3 units)**

*Course Description:* Exploration and creation of effective teaching practices based on examination of how high school students learn mathematics and science. Field experience in high school classrooms.

*Prerequisite(s):* Major in mathematics, science, or engineering; or completion of a one-year sequence of science or calculus and consent of the instructor.

*Learning Activities:* Lecture/Discussion 2 hour(s), Fieldwork.

*Enrollment Restriction(s):* Limited to 40 students per section.

*Cross Listing:* EDU 183.

*Grade Mode:* Letter.

*General Education:* Social Sciences (SS); Oral Skills (OL); Writing Experience (WE).

**GEL 185A – Conceptual Integrated Science for Non-Science Majors: The Physical World (2 units)**

*Course Description:* Conceptual, inquiry-based integrated science course. Topics in the Next Generation Science Standards. Elementary school level teaching practice. Physics, chemistry, and science inquiry.

*Learning Activities:* Lecture 1 hour(s), Discussion/Laboratory 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Scientific Literacy (SL).

**GEL 185B – Conceptual Integrated Science for Non-Science Majors: Earth System Science (2 units)**

*Course Description:* Conceptual, inquiry-based integrated science course. Topics in the Next Generation Science Standards. Elementary school level teaching practice. Earth, space and environmental science, and science inquiry.

*Learning Activities:* Lecture 1 hour(s), Discussion/Laboratory 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Scientific Literacy (SL).

**GEL 186 – Facilitating Learning in STEM Classrooms (1 unit)**

*Course Description:* STEM Learning Assistant Seminar. Theoretical and practical issues of effective teaching in discussion/labs: student-centered, active, cooperative learning environments, responsive teaching, and differentiated classroom instruction.

*Learning Activities:* Lecture/Discussion 1 hour(s).

*Grade Mode:* Letter.

*General Education:* Social Sciences (SS).

**GEL 190 – Seminar in Geology (1 unit)**

*Course Description:* Presentation and discussion of current topics in geology by visiting lecturers, staff, and students. Written abstracts.

*Learning Activities:* Discussion 1 hour(s), Seminar 1 hour(s).

*Repeat Credit:* May be repeated.

*Grade Mode:* Pass/No Pass only.

*General Education:* Science & Engineering (SE).

**GEL 192 – Internship in Geology (1-12 units)**

*Course Description:* Supervised work experience in geology.

*Prerequisite(s):* Upper division standing; project approval prior to internship.

*Learning Activities:* Internship.

*Repeat Credit:* May be repeated 10 unit(s).

*Grade Mode:* Pass/No Pass only.

*General Education:* Science & Engineering (SE).

**GEL 194A – Senior Thesis (3 units)**

*Course Description:* Guided independent study of a selected topic, leading to the writing of a senior thesis.

*Prerequisite(s):* Open to Geology majors who have completed 135 units and who do not qualify for the Honors Program.

*Learning Activities:* Variable.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Writing Experience (WE).

**GEL 194B – Senior Thesis (3 units)**

*Course Description:* Guided independent study of a selected topic, leading to the writing of a senior thesis.

*Prerequisite(s):* Open to Geology majors who have completed 135 units and who do not qualify for the Honors Program.

*Learning Activities:* Variable.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Writing Experience (WE).

**GEL 194HA – Senior Honors Project (3 units)**

*Course Description:* Guided independent study of a selected topic, leading to the writing of an honors thesis.

*Prerequisite(s):* Open to Geology majors who have completed 135 units and who qualify for the Honors Program.

*Learning Activities:* Independent Study 9 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Writing Experience (WE).

**GEL 194HB – Senior Honors Project (3 units)**

*Course Description:* Guided independent study of a selected topic, leading to the writing of an honors thesis.

*Prerequisite(s):* Open to Geology majors who have completed 135 units and who qualify for the Honors Program.

*Learning Activities:* Independent Study 9 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Writing Experience (WE).

**GEL 198 – Directed Group Study (1-5 units)**

*Course Description:* Group study focused on topics in Geology.

*Prerequisite(s):* Senior standing in Geology or consent of instructor.

*Learning Activities:* Variable 3-15 hour(s).

*Grade Mode:* Pass/No Pass only.

*General Education:* Science & Engineering (SE).

**GEL 199 – Special Study for Advanced Undergraduates (1-5 units)**

*Course Description:* Special study for advanced undergraduates.

*Learning Activities:* Variable.

*Grade Mode:* Pass/No Pass only.

*General Education:* Science & Engineering (SE).

**GEL 205 – Advanced Field Stratigraphy (3 units)**

*Course Description:* Fieldwork over spring break. Application of stratigraphic techniques to research problems. Collection, compilation, and interpretation of field data. Integration of data with models for deposition and interpretations of Earth history. Topics will vary. Offered irregularly.

*Prerequisite(s):* GEL 109; GEL 110; or consent of instructor; GEL 206 recommended.

*Learning Activities:* Lecture 1 hour(s), Fieldwork 2 hour(s).

*Repeat Credit:* May be repeated.

*Grade Mode:* Letter.

**GEL 206 – Stratigraphic Analysis (3 units)**

*Course Description:* Topics in advanced methods of stratigraphic analysis, regional stratigraphy and sedimentation, and sedimentary basin analysis. Emphasis on techniques used to interpret stratigraphic record and on current issues in stratigraphy and sedimentation. Offered irregularly.

*Prerequisite(s):* GEL 109; GEL 109L; or consent of instructor; GEL 144 recommended.

*Learning Activities:* Lecture 3 hour(s).

*Repeat Credit:* May be repeated when topic differs.

*Grade Mode:* Letter.

**GEL 214 – Active Tectonics (3 units)**

*Course Description:* Active deformation associated with faults, landslides, and volcanoes. Geodetic measurement techniques such as triangulation, trilateration, leveling, Global Positioning System (GPS), and radar interferometry. GPS data acquisition and analysis. Inversion of geodetic data and mechanical models of crustal deformation. Offered irregularly.

*Prerequisite(s):* Graduate standing or consent of instructor.

*Learning Activities:* Lecture/Discussion 3 hour(s).

*Grade Mode:* Letter.

**GEL 216 – Tectonics (3 units)**

*Course Description:* Nature and evolution of tectonic features of the Earth. Causes, consequences, and evolution of plate motion, with selected examples from the Earth's deformed belts. Offered irregularly.

*Prerequisite(s):* GEL 101; or consent of instructor.

*Learning Activities:* Lecture/Discussion 3 hour(s).

*Grade Mode:* Letter.

**GEL 217 – Topics in Geophysics (3 units)**

*Course Description:* Discussion and evaluation of current research in a given area of geophysics. Topic will change from year to year. Offered in alternate years.

*Prerequisite(s):* Consent of instructor.

*Learning Activities:* Lecture 1 hour(s), Seminar 2 hour(s).

*Repeat Credit:* May be repeated.

*Grade Mode:* Letter.

**GEL 218 – Analysis of Structures in Deformed Rocks (3 units)**

*Course Description:* Recent advances in the understanding and analysis of structures in brittlely and ductilely deformed rocks. Detailed investigation of the characteristics of the structures, models for their formation, and applications to inferring the kinematics of larger scale tectonics. Offered irregularly.

*Prerequisite(s):* GEL 101; GEL 101L; or consent of instructor.

*Learning Activities:* Seminar 3 hour(s).

*Grade Mode:* Letter.

**GEL 219 – Fracture & Flow of Rocks (3 units)**

*Course Description:* Origins of those structures in rocks associated with brittle and ductile deformation. Theoretical analysis, using continuum mechanics, and experimental evidence for the origin of the structures with emphasis on deformational processes in the earth. Offered irregularly.

*Prerequisite(s):* GEL 101; or consent of instructor.

*Learning Activities:* Lecture 3 hour(s).

*Grade Mode:* Letter.

**GEL 220 – Mechanics of Geologic Structures (3 units)**

*Course Description:* Development in tensor notation of the balance laws of continuum mechanics, and constitutive theories of elasticity, viscosity, and plasticity and their application to understanding development of geologic structures such as fractures, faults, dikes, folds, foliations, and boudinage. Offered irregularly.

*Prerequisite(s):* PHY 009A; MAT 021C; or consent of instructor; MAT 021D and (MAT 022A or MAT 027A or BIS 027A recommended.)

*Learning Activities:* Lecture 3 hour(s).

*Grade Mode:* Letter.

**GEL 226 – Advanced Sedimentary Petrology (3 units)**

*Course Description:* Advanced petrography and geochemistry of sediments and sedimentary rocks. Geochemical, textural and mineralogical evolution of sedimentary rocks reflecting depositional or burial processes. Laboratory work emphasizes thin section study of rocks. Offered irregularly.

*Prerequisite(s):* GEL 144; or consent of instructor.

*Learning Activities:* Lecture 2 hour(s), Laboratory 3 hour(s).

*Repeat Credit:* May be repeated when topic differs.

*Grade Mode:* Letter.

**GEL 227 – Stable Isotopes Biogeochemistry (4 units)**

*Course Description:* Discussion and application of stable isotope techniques for scientific research problems. Emphasizes carbon, oxygen, nitrogen, hydrogen and sulfur isotopes. Laboratory develops basic skills of cryogenic gas extraction and specific techniques for individual research using stable isotopes. Offered irregularly.

*Prerequisite(s):* Consent of instructor; graduate standing.

*Learning Activities:* Lecture 2 hour(s), Laboratory 6 hour(s).

*Grade Mode:* Letter.

**GEL 228 – Topics in Paleoceanography (3 units)**

*Course Description:* Critical discussion and review of selected topics in paleoceanography and paleoclimatology relating to the history of the processes controlling and affecting climate change and ocean circulation throughout the geologic record. Topics vary. Offered irregularly.

*Prerequisite(s):* GEL 108; GEL 150A; or consent of instructor.

*Learning Activities:* Lecture 3 hour(s).

*Repeat Credit:* May be repeated.

*Grade Mode:* Letter.

**GEL 230 – Geomorphology & River Management (3 units)**

*Course Description:* Impacts of management and land use activities on the geomorphology of rivers and streams. Evaluation and use of analytical tools for river assessment. Assessment of river and stream restoration strategies and emerging issues in river management.

*Prerequisite(s):* GEL 139; or equivalent; graduate standing.

*Learning Activities:* Seminar 3 hour(s).

*Repeat Credit:* May be repeated when topic differs.

*Grade Mode:* Letter.

**GEL 232 – Oceans & Climate Change (3 units)**

*Course Description:* Modern climate change and linkages between the ocean-atmosphere-cryosphere-terrestrial climate system. Importance of the ocean in forcing climate change, and the impacts of anthropogenic processes on the ocean. Topics vary. Offered irregularly.

*Prerequisite(s):* Graduate standing or consent of instructor.

*Learning Activities:* Lecture/Discussion 3 hour(s).

*Repeat Credit:* May be repeated 3 time(s).

*Grade Mode:* Letter.

**GEL 235 – Surface Processes (3 units)**

*Course Description:* Recent advances in the analysis of landforms and their evolution. Detailed investigation of the tools used to document surface processes. Evaluation of concepts and processes that govern landscape evolution. Offered irregularly.

*Prerequisite(s):* GEL 050; GEL 050L; MAT 016B or MAT 017B or MAT 019B or MAT 021B recommended.

*Learning Activities:* Seminar 3 hour(s).

*Repeat Credit:* May be repeated.

*Grade Mode:* Letter.

**GEL 236 – Inverse Theory in Geology & Geophysics (3 units)**

*Course Description:* Inversion of data for model parameters. Evaluation of parameter uncertainties. Linear and nonlinear problems for discrete and continuous models. Bakus-Gilbert inversion. Offered irregularly.

*Prerequisite(s):* Consent of instructor.

*Learning Activities:* Lecture 3 hour(s).

*Grade Mode:* Letter.

**GEL 238 – Theoretical Seismology (3 units)**

*Course Description:* Elastodynamic wave equation. Greens functions and source representations. Ray theory. Plane and spherical waves and boundary conditions. Elastic wave propagation in stratified media.

*Prerequisite(s):* Consent of instructor.

*Learning Activities:* Lecture 3 hour(s).

*Grade Mode:* Pass/Fail only.

**GEL 240 – Geophysics of the Earth (3 units)**

*Course Description:* Physics of the earth's crust, mantle, and core.

Laplace's equation and spherical harmonic expression of gravity and magnetic fields. Elastic wave equation in geologic media. Body and surface seismic waves. Equations of state, thermal structure of the earth. Offered irregularly.

*Prerequisite(s):* PHY 009B; (MAT 022B or MAT 027B or BIS 027B).

*Learning Activities:* Lecture 3 hour(s).

*Grade Mode:* Letter.

**GEL 241 – Geomagnetism (3 units)**

*Course Description:* Nature and origin of the Earth's magnetic field.

Present field and recent secular variation. Spherical harmonic analysis. Paleosecular variation. Polarity transitions and geomagnetic excursions. Statistics of polarity intervals. Dynamo theory. Planetary magnetism. Offered irregularly.

*Prerequisite(s):* Graduate standing.

*Learning Activities:* Lecture 3 hour(s).

*Grade Mode:* Letter.

**GEL 242 – Paleomagnetism (3 units)**

*Course Description:* Principles and applications of paleomagnetism.

Physical basis of rock and mineral magnetism. Field and laboratory techniques. Instrumentation. Analysis of paleomagnetic data. Statistical methods. Rock magnetic properties. Geological and geophysical applications. Offered irregularly.

*Prerequisite(s):* Graduate standing.

*Learning Activities:* Lecture 3 hour(s).

*Grade Mode:* Letter.

**GEL 246 – Physical Chemistry of Metamorphic Processes (3 units)**

*Course Description:* Physiochemical principles of metamorphic mineral assemblages and methods of interpreting the paragenesis of metamorphic rocks. Offered irregularly.

*Prerequisite(s):* GEL 145; CHE 110A; or consent of instructor.

*Learning Activities:* Lecture 3 hour(s).

*Grade Mode:* Letter.

**GEL 247 – Metamorphic Petrology Seminar (3 units)**

*Course Description:* Selected topics in metamorphic petrology (e.g., mass transport processes, tectonic settings, geothermometry, thermal structure of metamorphic belts, regional studies). Offered irregularly.

*Prerequisite(s):* GEL 145; or consent of instructor; GEL 246 recommended.

*Learning Activities:* Seminar 3 hour(s).

*Repeat Credit:* May be repeated.

*Grade Mode:* Satisfactory/Unsatisfactory only.

**GEL 250 – Advanced Geochemistry Seminar (3 units)**

*Course Description:* Critical review of selected topics in geochemistry including: ore genesis, hydrothermal and geothermal fluids, recent and ancient sediments, isotope geology, origin and chemistry of the oceans. Subject varies yearly depending on student interest.

*Prerequisite(s):* GEL 146; or consent of instructor.

*Learning Activities:* Seminar 3 hour(s).

*Repeat Credit:* May be repeated.

*Grade Mode:* Letter.

**GEL 251 – Advanced Topics in Isotope Geochemistry & Cosmochemistry (3 units)**

*Course Description:* Astrophysical context on origin of Solar System, synthesis of chemical elements, condensation sequence, star and planet formation, cosmochronology, building blocks of planets, development on planets' layered structure, atmosphere and hydrosphere and the role of comets/asteroids for volatile delivery. Offered irregularly.

*Prerequisite(s):* Graduate standing or consent of instructor.

*Learning Activities:* Lecture/Discussion 2 hour(s), Term Paper.

*Repeat Credit:* May be repeated 3 time(s) when topics differs.

*Grade Mode:* Letter.

**GEL 253 – Current Topics in Igneous Petrology (3 units)**

*Course Description:* Topical seminar designed to help graduate students develop and maintain familiarity with current and past literature related to igneous rock petrogenesis.

*Prerequisite(s):* GEL 143; or consent of instructor; graduate standing in Geology.

*Learning Activities:* Seminar 3 hour(s).

*Repeat Credit:* May be repeated when topic differs.

*Grade Mode:* Satisfactory/Unsatisfactory only.

**GEL 254 – Physical Chemistry of Igneous Processes (3 units)**

*Course Description:* Introduction of modern concepts in chemical thermodynamics and kinetics, and fluid dynamics of magmatic systems for graduate students in petrology. Offered irregularly.

*Prerequisite(s):* CHE 110A; GEL 143; and consent of instructor; GEL 143 or consent of instructor; CHE 110B and CHE 110C recommended.

*Learning Activities:* Lecture 3 hour(s).

*Grade Mode:* Letter.

**GEL 255 – Experimental Petrology (3 units)**

*Course Description:* Introduction to techniques and methods of design and executing experiments on Earth-forming minerals and rocks. Problems and examples from igneous and metamorphic petrology will be utilized. Offered irregularly.

*Prerequisite(s):* GEL 143; or consent of instructor.

*Learning Activities:* Lecture 2 hour(s), Laboratory 3 hour(s).

*Grade Mode:* Letter.

**GEL 260 – Paleontology (3 units)**

*Course Description:* Selected problems in paleontology. Subject to be studied will be decided at an organizational meeting. Offered irregularly.

*Prerequisite(s):* Graduate standing in geology or a biological science.

*Learning Activities:* Seminar 3 hour(s).

*Repeat Credit:* May be repeated when topic differs.

*Grade Mode:* Letter.



### **GEL 261 – Paleobiology Graduate Seminar 1: Evolutionary Aspects (3 units)**

*Course Description:* Treat one or more of several topics in paleobiology from a phylogenetic perspective, including major patterns in evolution, building the tree of life, extinction & phylogeny, phylogeny of major phyla, and the relation between taxonomy & phylogeny.

*Prerequisite(s):* Graduate standing in Geology or a biological science; qualified undergraduates will be accepted on an exception-only basis.

*Learning Activities:* Lecture 1 hour(s), Seminar 2 hour(s).

*Repeat Credit:* May be repeated when topic differs.

*Grade Mode:* Letter.

### **GEL 262 – Paleobiology Graduate Seminar: Methodological Aspects (3 units)**

*Course Description:* One or more major methods used in the study of fossils: Morphometrics and three-dimensional reconstruction of fossils, phylogenetic methodology, the application of geochemical techniques, and electron microscopy.

*Learning Activities:* Lecture 1 hour(s), Seminar 2 hour(s).

*Repeat Credit:* May be repeated 4 time(s) when topic differs.

*Grade Mode:* Letter.

### **GEL 281N – Instrumental Techniques for Earth Scientists (3 units)**

*Course Description:* Laboratory research techniques for new graduate students in Geology. Demonstration of and exposure to appropriate techniques in research.

*Prerequisite(s):* (MAT 016A or MAT 017A or MAT 019A or MAT 021A); (MAT 016B or MAT 017B or MAT 019B or MAT 021B); (MAT 016C or MAT 017C or MAT 019C or MAT 021C); ((PHY 007A or PHY 009A); (PHY 007B or PHY 009B); (PHY 007C or PHY 009C)); or consent of instructor.

*Learning Activities:* Lecture 2 hour(s), Laboratory 3 hour(s).

*Grade Mode:* Letter.

### **GEL 285 – Field Studies in Marine Geochemistry (2-8 units)**

*Course Description:* Marine geochemistry with the opportunity of going to sea or into the field on land. Techniques of seafloor mapping using bottom photography, marine geochemical sampling, and method of data reduction and sample analysis. Analysis of data/samples collected.

*Prerequisite(s):* Consent of instructor.

*Learning Activities:* Lecture 3 hour(s), Laboratory 1-3 hour(s), Fieldwork 6-40 hour(s).

*Grade Mode:* Letter.

### **GEL 290 – Seminar in Geology (1 unit)**

*Course Description:* Presentation and discussion of current topics in geology by visiting lecturers, staff, and students.

*Learning Activities:* Seminar 1 hour(s), Discussion 1 hour(s).

*Grade Mode:* Satisfactory/Unsatisfactory only.

### **GEL 291 – Geology of the Sierra Nevada (1 unit)**

*Course Description:* Short oral presentations by students and faculty concerning results of their past work and plans for future work in the Sierra. A written abstract is required following the format required at professional meetings. Offered irregularly.

*Prerequisite(s):* Consent of instructor.

*Learning Activities:* Seminar.

*Repeat Credit:* May be repeated.

*Grade Mode:* Satisfactory/Unsatisfactory only.

### **GEL 292 – River Forum (1 unit)**

*Course Description:* Review and discussion of latest research and fundamental issues surrounding riverine systems, with emphasis on physical processes. Topics vary. Offered irregularly.

*Prerequisite(s):* Graduate standing.

*Learning Activities:* Seminar 1 hour(s).

*Repeat Credit:* May be repeated.

*Grade Mode:* Satisfactory/Unsatisfactory only.

### **GEL 293 – Geologic Event of the Week (1 unit)**

*Course Description:* Seminar/discussion group to review and discuss recent earthquakes, volcanic eruptions, and other significant geologic events. The focus is on understanding the available observations, the physical processes behind each event, the geological setting, and societal consequences. Offered irregularly.

*Prerequisite(s):* Graduate standing.

*Learning Activities:* Seminar 0.50 hour(s), Discussion 0.50 hour(s).

*Repeat Credit:* May be repeated 3 time(s) up to 3 units.

*Grade Mode:* Satisfactory/Unsatisfactory only.

### **GEL 294 – Structure/Tectonics Forum (1 unit)**

*Course Description:* Seminar/discussion group to review and discuss latest research in structural geology and tectonics, and on-going research of participants. Topics will vary each quarter depending on the interests of the group. Occasional field trips to areas of current interest.

*Prerequisite(s):* Graduate student in geology or consent of instructor.

*Learning Activities:* Seminar 1 hour(s).

*Repeat Credit:* May be repeated when topic differs.

*Grade Mode:* Satisfactory/Unsatisfactory only.

### **GEL 295 – Geophysics Forum (1 unit)**

*Course Description:* Seminar/discussion group to review and discuss latest research in geophysics, and on-going research of participants. Topics will change each quarter depending on the interests of the group. Offered irregularly.

*Prerequisite(s):* GEL 101; or consent of instructor.

*Learning Activities:* Seminar 0.50 hour(s), Discussion 0.50 hour(s).

*Repeat Credit:* May be repeated when topic differs.

*Grade Mode:* Satisfactory/Unsatisfactory only.

### **GEL 296 – Advanced Problems in Tectonics (3 units)**

*Course Description:* Seminar dealing with current problems in tectonics of selected regions. Topics will change from year to year. Emphasis on study of recent literature. Offered irregularly.

*Prerequisite(s):* GEL 101; consent of instructor.

*Learning Activities:* Seminar 3 hour(s).

*Repeat Credit:* May be repeated.

*Grade Mode:* Satisfactory/Unsatisfactory only.

### **GEL 297 – Geophysics Forum (1 unit)**

*Course Description:* Seminar/discussion group to review and discuss latest research in geophysics, and on-going research of participants. Topics will change each quarter depending on the interests of the group. Offered irregularly.

*Prerequisite(s):* Graduate student status in the Geology Department, or consent of instructor.

*Learning Activities:* Seminar 0.50 hour(s), Discussion 0.50 hour(s).

*Repeat Credit:* May be repeated 3 time(s).

*Grade Mode:* Satisfactory/Unsatisfactory only.

### **GEL 298 – Group Study (1-5 units)**

*Course Description:* Group study.

*Learning Activities:* Variable.

*Grade Mode:* Letter.

### **GEL 299 – Research (1-12 units)**

*Course Description:* Research.

*Learning Activities:* Variable.

*Grade Mode:* Satisfactory/Unsatisfactory only.

### **GEL 390 – Methods of Teaching Geology (2 units)**

This version has ended; see updated course, below.

*Course Description:* Introduction to graduate-level writing and undergraduate-level teaching skills in geology. Persuasive (proposal) writing workshop; discussions on campus teaching resources, presenting information, managing classroom dynamics, evaluating student performance. Participation in teaching program required for Ph.D. in Geology.

*Prerequisite(s):* Graduate student standing in Geology.

*Learning Activities:* Extensive Writing/Discussion 2 hour(s).

*Grade Mode:* Satisfactory/Unsatisfactory only.

### **GEL 390 – Methods of Teaching & Research (1-5 units)**

*Course Description:* Introduction to academia at UC Davis. Introduction to graduate-level research, professional development skills, and methods for undergraduate-level teaching. Includes methods in scientific communication (written, oral and poster presentations); literature review and synthesis; professional development; discussions on campus teaching resources, presenting information, managing classroom dynamics, and assessing student's work.

*Learning Activities:* Extensive Writing/Discussion 1-5 hour(s).

*Enrollment Restriction(s):* Restricted to graduate students in Earth & Planetary Sciences.

*Repeat Credit:* May be repeated 3 times when topic differs.

*Grade Mode:* Satisfactory/Unsatisfactory only.

This course version is effective from, and including: Winter Quarter 2025.

### **GEL 391 – Ethical Issues in Earth Science (1 unit)**

*Course Description:* Reading and discussion of ethical issues arising in the earth sciences. Topics include scientific misconduct, gender equity in science, authorship of scientific papers, establishing priorities in research, and related issues. Offered irregularly.

*Prerequisite(s):* Graduate standing in Geology or consent of instructor.

*Learning Activities:* Seminar 1 hour(s).

*Grade Mode:* Satisfactory/Unsatisfactory only.

### **GEL 396 – Teaching Assistant Training Practicum (1-4 units)**

*Course Description:* Teaching assistant training.

*Learning Activities:* Variable.

*Repeat Credit:* May be repeated.

*Grade Mode:* Pass/No Pass only.