of design including environmental, costume, textile, museum, display and interior design. (P/NP grading only.)

194HA. Special Study for Honors Students (3)

Independent study—9 hours. Prerequisite: course 194HA; qualification for Letters and Science Honors Program; senior standing; consent of instructor. Limited enrollment. Preparation and presentation of a culminating project. Supervision of an instructor in one of the creative or scholarly areas of Design. (Deferred grading only, pending completion of sequence.)—W. (W.)

194HB. Special Study for Honors Students (3)

Independent study—9 hours. Prerequisite: course 194HA; qualification for Letters and Science Honors Program; senior standing; consent of instructor. Limited enrollment. Preparation and presentation of a culminating project. Supervision of an instructor in one of the creative or scholarly areas of Design. (Deferred grading only, pending completion of sequence.)—S. (S.)

197T. Tutoring in Design (1-5)

Discussion groups or studio meetings affiliated with one of the department’s regular courses. (P/NP grading only.)

198. Directed Group Study (1-5)

Prerequisite: upper division standing and consent of instructor. Leading of small discussion groups or studio meetings affiliated with one of the department’s regular courses. (P/NP grading only.)

199. Special Study of Advanced Undergraduates (1-5)

(P/NP grading only.)

Graduate

221. Theory and Issues in Design (4)

Seminar—3 hours; independent study. Prerequisite: graduate standing in Design or consent of instructor. Perspectives on theoretical and aesthetic issues related to the design professions such as methodology in historical and contemporary contexts, implications of trainings in design theory and practice, and design relationships to environmental sustainability, recycling, and other social issues. May be repeated one time for credit.—W. (W.)

222. Research Methods and Critical Writing for Design (4)

Seminar—3 hours; independent study. Prerequisite: course 221; graduate standing in Design or consent of instructor. Focused on research methods and critical writing related to design topics including case studies, original and secondary sources, critical reviews. Expectation of a paper meeting professional standards suitable for publication from each student at end of course. May be repeated one time for credit.—W. (W.)

223. Professional Practice and Ethics in Design (4)

Seminar—3 hours; independent study. Prerequisite: courses 221, 222; graduate standing in Design or consent of instructor. Introduce students to issues of professional design practice: business ethics, contracts and business practices, social responsibility through case studies, guest lectures and field trips, and readings. Short written assignments and presentations will be required. —S. (S.)

224. Seminar in Design Research and Teaching (4)

Independent study—6 hours; extensive writing—4 hours; discussion—2 hours. Prerequisite: courses 221, 222, 223; concurrent academic appointment [TA] in courses 142A, 142B, 143, 144, 145; graduate standing in Design; consent of instructor. Student will work closely with instructor on a research and writing project related to subject matter of undergraduate design courses noted above with the goal of introducing students to advanced historical research processes and development of writing skills. May be repeated two times for credit.—F, W, S. (F, W, S.)

225. Studio Practice in Design (4)

Studio—3 hours. Prerequisite: course 221. Restricted to graduate standing in Design or consent of instructor. Students work together on a collective project to experience the multiple phases of design through an iterative process. Design projects will be geared towards relevance in contemporary social, cultural and political contexts. May be repeated two times for credit.—W. (W.)

290. Seminar in Design (4)

Seminar—4 hours. Prerequisite: graduate standing or consent of instructor. Selected topics in design methodology, research, communication, and education. May be repeated for credit.—S. (S.)

292. Practicum in Design (1-12)

Prerequisite: graduate standing in Design or consent of instructor. Supervision of an instructor in one of the creative or scholarly areas of Design. May be repeated for credit.—W. (W.)

298. Directed Group Study for Graduate Students (1-5)

Studio. Prerequisite: consent of instructor. (S/U grading only.)

299. Individual Focused Study (1-12)

Prerequisite: graduate standing in Design or consent of instructor. Advanced study in studio practice on independent projects with faculty consultation. May be repeated for credit.—F, W, S. (F, W, S.)

299D. Project Concentration (1-12)

Prerequisite: graduate standing in Textile Arts and Costume Design or consent of instructor. A minimum of 22 units must be taken in Project Concentration and Individual Focused Study. Student creates a body of original work at a professional level, with written and visual documentation of process and concepts underlying the project, culminating in public presentation. (S/U grading only)—S. (S.)

Professional

396. Teaching Assistant Training Practicum (1-4)

Prerequisite: graduate standing. May be repeated for credit. (S/U grading only)—F, W, S. (F, W, S.)

Dietetics

See Clinical Nutrition, on page 216.

Dramatic Art

See Theatre and Dance, on page 568.

Earth and Planetary Sciences

[College of Letters and Science]

Dawn Y. Sumner, Ph.D., Chairperson of the Department

David A. Osleger, Ph.D., Vice-Chairperson of the Department

Department Office. 2119 Earth and Physical Sciences Building 530-752-0350; http://www.geology.ucdavis.edu

Faculty

Maggie I. Billen, Ph.D., Professor

Sandra J. Carlsson, Ph.D., Professor

William H. Casey, Ph.D., Professor (Chemistry)

Kari M. Cooper, Ph.D., Professor

Eric S. Cowgill, Ph.D., Professor

Graham E. Fogg, Ph.D., Professor

(land, Air and Water Resources)

Tessa M. Hill, Ph.D., Associate Professor

Louise H. Kellogg, Ph.D., Professor

Charles E. Lesher, Ph.D., Professor

James S. McClain, Ph.D., Professor

Academic Senate Distinguished Teaching Award

Isabel P. Montañez, Ph.D., Professor

Academic Senate Distinguished Teaching Award

Ryo Sukey Matani, Ph.D., Professor

Academic Senate Distinguished Teaching Award

Sujoy Mukhopadhyay, Ph.D., Professor

Alexandra Navrotsky, Ph.D., Professor (Chemistry)

Michael F. Oskin, Ph.D., Professor

Academic Senate Distinguished Teaching Award

David A. Osleger, Ph.D., Lecturer SOE

Academic Senate Distinguished Teaching Award

Nicholas Pinter, Ph.D., Professor

Academic Senate Distinguished Teaching Award

John B. Rundle, Ph.D., Professor (Physics, Earth and Planetary Sciences)

Howard J. Spero, Ph.D., Professor

Sarah T. Stewart, Ph.D., Professor

Dawny Y. Sumner, Ph.D., Professor

Kenneth L. Verosub, Ph.D., Professor

Academic Senate Distinguished Teaching Award

Zeng-qin Yin, Ph.D., Professor

Robert A. Zierenberg, Ph.D., Professor

Emeriti Faculty

Cathy J. Busby, Ph.D., Professor Emerita

Richard Cowen, Ph.D., Senior Lecturer Emeritus

Academic Senate Distinguished Teaching Award

Howard W. Day, Ph.D., Professor Emeritus

John E. Dewey, Ph.D., Professor Emeritus

James A. Doyle, Ph.D., Professor Emeritus (Evolution and Ecology)

Charles G. Higgins, Ph.D., Professor Emeritus

Eldridge M. Moores, Ph.D., Professor Emeritus

Jeffrey F. Mount, Ph.D., Professor Emeritus

James R. Rustad, Ph.D., Professor Emeritus

Peter Schiffman, Ph.D., Professor Emeritus

Donald L. Turcotte, Ph.D., Professor Emeritus

Robert J. Twiss, Ph.D., Professor Emeritus

Major Programs. See Geology, Marine and Coastal Science, and Natural Sciences.

Courses. See courses listed under Geology.

Geology Major Programs

“Civilization exists by geological consent—subject to change without notice.” —Will Durant

Geology is the study of the Earth, and in particular its history, structure, and the processes that have shaped our planet over its vast timespan. Geology involves the study of the origin of continents and ocean basins, earthquakes and volcanoes, variations in global climate, and how these physical changes impact the evolution of life. All of these planetary processes are viewed through the prism of “deep time,” a perspective unique to geologists and one that distinguishes geology from most of the other physical sciences.

A significant component of geology is oriented toward the interaction between the Earth and its biosphere. Geology involves the study of resources such as minerals, oil, and water; identification and mitigation of Earth hazards such as earthquakes, landslides, floods, and volcanic eruptions; identification and mitigation of polluted ground water; land use planning; and the study of ancient and modern climate change.

The Program. Students interested in becoming professional geologists or continuing their geological studies at the graduate level should choose the Bachelor of Science degree program. The Bachelor of Arts program is for students interested in an interdisciplinary program of study who plan to go into pre-college teaching. Both programs allow students to emphasize an aspect of the field of particular interest to them. The upper division electives are not restricted to geology courses but must be chosen to provide a relevant, coherent, and in-depth program of study. Transfer students should have completed as much as possible of the preparatory subject matter listed below.

Internships and Career Alternatives. In recent years in California, the largest employers of geologists have been environmental and geotechnical consulting firms, with oil companies, research laboratories and government agencies providing opportunities. Students graduating with a Bachelor’s degree may get entry-level positions in the private sector.
B.S. Major Requirements:

Education Abroad Options. The department strongly encourages interested students to pursue a portion of their studies abroad. Within the constraints of the UCD Pre-college Level College residence requirements, it is possible for students to complete significant portions of the Geology major at an international institution provided that the student consults with one of the undergraduate advisers and carefully plans a course of study abroad that will complement their coursework at Davis. In recent years, UC Davis Geology majors have spent their junior or senior years completing upper division coursework at EPA partner institutions in New Zealand, Ghana, Chile, and the United Kingdom.

A.B. Major Requirements:

Preparatory Subject Matter ..................40-43
Geology 3, 31, 50, 50L, 60, 60L ............13
Mathematics 16A-16B or 21A-21B ...........6-8
Chemistry 2A-2B ..................................10
Physics 7A-7B ...................................10
Statistics 13 or 13V or 32 or 100 ............3-4

Depth Subject Matter .........................36
Additional upper division electives chosen from Geology 130-194 courses (only one of GE/EDU 181 or GE/EDU 183 may be applied toward elective credit), Hydrologic Science 144, 146 and related fields approved in advance by major adviser. No more than three units upper division elective credit for Geology 120 courses. Maximum of six units upper division elective credit for Geology 192 or 194A-194B or 194A-194BH ..........................16

Total Units for the Major ......................76-79

Recommended. Chemistry 100 or Hydrologic Science 134, Physics 7C.

B.S. Major Requirements:

Preparatory Subject Matter ..................57-59
Geology 3, 31, 50, 50L, 60, 62 ................15
Mathematics 21A-21B-21C ....................12
Chemistry 2A-2B ..................................10
Select one of the following three options:
General Geology emphasis: Geology 2 or Geology 132 or Hydrologic Science 134 ..................5-6
Geoscience/Geophysics emphasis: Chemistry 2 or Geology 132 or Hydrologic Science 134 ..................5-6
Quantitative/Geophysics emphasis: Mathematics 21D ..................4

Minor Advisers. J.M. McClain, R. Motani, M.E. Oskin

Minor Program Requirements: Students majoring in Geology can acquire a minor in the related chemistry, Geophysics or Environmental Geology. The requirements for those minors are listed alphabetically in this Catalog.

Geology ...........................................19-24
Select one of the four emphases below.
General Geology emphasis ....................19-20
Geology 50 or 110L and 110L ..................6-7
Geology 101, 107, 108, 109 .................11-12
Geology 116 or 134 ..............................3

Minor Advisers. Same as major advisers.

Chemistry emphasis .........................19-22
Geology 50 and 50L ..............................5
Chemical Engineering 171, 171I ............15
Three courses from: Geology 134, 161, 162, Hydrologic Science 103, 144, 146, Soil Science 118, 120, 123, 124 ............9-12

Minor Advisers. Same as major adviser.

Geochemistry emphasis ......................19-22
Geology 60 and either 146 or 147 ............7-8
Chemistry 110A and 110B, or Materials Science and Engineering 130 and 134 ..............6-9
Chemistry majors may substitute one of the elective courses for Chemistry 110B.
Two electives from Chemistry 110C, Geology 108, 146, 148, Hydrologic Science 134, Soil Science 102 .................................6-9
Chemistry 110C and Materials Science and Engineering 134 cannot both be counted toward the minor.

Minor Advisers. Same as major advisers.

Petrology/Biochemistry emphasis ............20-21
Geology 107, 107L, 108 .......................9-10
Geology 141 or 144 .............................4-5
At least nine additional units from: Anthropology 153, 150, Evolution and Ecology 100, 101, 102, 105, 112, 112L, 140, 149, Geology 109, 150C ............8-9

Minor Advisers. R. Motani, G. Vermeij

Science Teaching Credential. Students who wish to become a teacher should consult adviser in the CalTeach/Mathematics and Science Teaching Program (CalTeach/MAST, mast.ucdavis.edu) at their first opportunity in order to combine the requirements for a credential program with General Education requirements. CalTeach/MAST also offers seminars that give participants required experience in elementary, middle school, and high school classrooms. Students hoping to teach at Earth and Planetary Science may prepare by satisfying the requirements for the B.S. in Earth and Planetary Sciences (http://naturalsciences.ucdavis.edu) or the A.B. degree in Geology (76-79 units) and 34 additional units of science as outlined below. Students may also prepare for the science credential by completing the B.S. degree in Geology (109-111 units) and an additional 22 units as indicated by the asterisks (*) below.

Related Program. See also Marine and Planetary Science, on page 124.

Graduate Study. The department offers programs of study and research leading to the M.S. and Ph.D. degrees in Geology. For more information, see http://geology.ucdavis.edu/students/grad.

Graduate Advisers. M.L. Billen, E.S. Cowgill, S. Mukhopadhyay

Natural Sciences Major Program

The Major Program

Natural Sciences is an interdisciplinary major that provides significant breadth in biology, chemistry, earth sciences, physics and mathematics while offering additional depth in two of the natural sciences. It is especially designed to meet the needs of prospective science teachers, but will also serve students who wish to acquire training in more than one science. The major is sponsored by the Department of Earth and Planetary Sciences.

The Program. The Natural Sciences curriculum offers an unusually broad training in science and mathematics. All students must complete one year sequence in calculus, a course in statistics and one year sequence in chemistry, earth science, life science and physics. Each student will complete depth courses in two of these sciences. Prospective teachers may use these depth courses as preparation for primary and supplementary science teaching credentials in science. Students who might wish to prepare for a teaching credential program should consult an adviser at their first opportunity in order to combine the prerequisites with General Education requirements.

Career Alternatives. Students whose goals include business, journalism, law, or medicine may acquire a broad background in science through this curriculum. The study of natural sciences also prepares a student to meet the subject matter requirements for primary and supplementary science teaching credentials in California. Students who might wish to become a teacher should consult an adviser in the CalTeach/Mathematics and Science Teaching Program (CalTeach/MAST, mast.ucdavis.edu) at their first opportunity. CalTeach/MAST advisers can help students combine the prerequisites for a credential program with General Education requirements. The program also offers seminars that give participants experience in elementary, middle school, and high school classrooms.

B.S. Major Requirements:

Preparatory Subject Matter .................68-74
Geology 2A-2B-2C ...............................15
Supplementary Fields:

Chemistry .......................... 15
Chemistry 107A-107B or 110A-110B-110C .... 6-12
Chemistry 118A-118B or 128A-128B-129A-129B ... 8-10
Chemistry 124A. 3
One course from Chemistry 100, 104, 118C, 128C ... 3-4
Three units from Chemistry, 197, 199 or Education/Geology 181, 183 ... 3
Earth Science .......................... 27
Geology 62, 101, 101L, 105, 109, 109L, 113, 119L, 121 ... 21
Once course from Geology 107, 108, 131, 144 ... 3
Three units from Geology or Education/Geology 181, 183 ... 3
Life Science .......................... 27-33
Chemistry 8A-8B or 118A-118B-118C ..... 6-12
Biological Sciences 101 ... 4
Evolution and Ecology 100, 101 or approved electives and Biological Sciences 105 ... 8
Neurobiology, Physiology, and Behavior 101 ... 5
Four units from Biological Sciences 199, Evolution and Ecology 199, Molecular and Cellular Biology 199, or Neurobiology, Physiology, and Behavior 199 or Education/Geology 181, 183 ... 4
Physics ................................. 27
Chemistry 107A, 110A ... 7
Geology 161, 162, 163A, 163B, 163C ... 9
Physics 108, 108L, 160 ... 7
Four units from Physics 199 or Education/Geology 181, 183 ... 4

Supplementary Fields:

Chemistry .......................... 15-17
Chemistry 100 ... 3
Chemistry 104 or 105 ... 3-4
Chemistry 107A ... 3
Chemistry 118A or 128A ... 3-4
Chemistry 124A ... 3
Other Chemistry or related science courses may be substituted with the prior approval of the major adviser.

Earth Science .......................... 15
Geology 105, 109, 109L, 116N ... 10
Geology 138 or 140 ... 4
Approved elective ... 1
Other Geology or related science courses may be substituted with the prior approval of the major adviser.

Life Science .......................... 15
Biological Sciences 101* ... 4
Evolution and Ecology 100 ... 4
Neurobiology, Physiology, and Behavior 101 ... 5
Approved electives ... 2
Other Biological Sciences or related science courses may be substituted with the prior approval of the major adviser.

Physics ................................. 15
Physics 108 ... 7

Chemistry 107A ...................... 7
Geology 161, 162, 163A, 163B, 163C ... 9
Approved electives ... 4
Other Physics or related science courses may be substituted with the prior approval of the major adviser.

Major Advisers: T.M. Hill, R. Motani

Related Major Program: See also Marine and Coastal Science, on page 416.

Courses in Geology (GE)

Lower Division

1. The Earth (4)

Lecture—3 hours; discussion—1 hour. Introduction to the study of the Earth. Earth's physical and chemical structure, interactions that mold the Earth; geological hazards and resources. Not open for credit to students who have completed course 50. Only 2 units of credit to students who have completed course 2. GE credit: SciEng | SE, SL, WE. —F, W, F (W), S (W), J Hill, Los Angeles

2. The Blue Planet: Introduction to Earth Science (3)

Lecture—3 hours. Study of the solid and fluid earth and its place in the universe. Holographic examination of how the solid earth interacts with the atmosphere, hydrosphere, biosphere, and extraterrestrial environment. Not open for credit to students who have completed course 50. Only 2 units of credit to students who have completed course 1. GE credit: SciEng | SE, SL —W. (W), Montañez

2G. The Blue Planet: Introduction to Earth Science Discussion (1)

Discussion—1 hour. Prerequisite: course 2 concurrently. Small group discussion and preparation of short papers for course 2. GE credit: SciEng, Wrt | SE, SL —W. (W), Montañez

3. History of Life (3)

Lecture—3 hours. Prerequisite: course 1 recommended. The history of life during the three and one-half 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. GE credit: SciEng | SE —W. (W), Motani

3G. History of Life: Discussion (1)

Discussion—1 hour. Prerequisite: course 3 concurrently. Small group discussion and preparation of short papers for course 3. GE credit: SciEng, Wrt | SE, SL, WE —W. (W), Motani

3L. History of Life Laboratory (1)

Exercises in understanding fossils as the clues to interpreting ancient life, including their functional morphology, paleoecology, and evolution. GE credit: SciEng | SE —W. (W), Motani

4. Evolution: Science and World View (3)

Lecture—3 hours; discussion—1 hour. 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 evolution on thought on other disciplines. GE credit: SciEng | SE, SL, WE. —S. (S.) Vermeij

10. Modern and Ancient Global Environmental Change (3)

Lecture—3 hours. 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 change throughout Earth’s history. GE credit: SciEng | SE, SL, VL —F. (F), Montañez

12. Evolution and Paleobiology of Dinosaurs (2)

Lecture—2 hours. Introduction to evolutionary biology, paleobiology, ecology and paleoecology, using dinosaurs as case studies. GE credit: SciEng | SE —F, W, F, W, J Carlson

16. The Oceans (3)

Lecture—3 hours. Introductory survey of the marine environment. Oceanic physical phenomena, chemical constituents and chemistry of water, geological history, the sea floor and current utilization of marine resources. Not open for credit to students who have taken course 16G. GE credit: SciEng | SE, SL —W, S, W, J Hill, Spero

16G. The Oceans: Discussion (2)

Discussion/lab—2 hours; term paper or discussion. Prerequisite: course 16 concurrently. Scientific method applied to the discovery of the oceans and their history. Group discussion and preparation of term paper. Not open for credit to students who have taken course 16G. GE credit: SciEng, Wrt | SE, WE —W. (W), Hill

17. Earthquakes and Other Earth Hazards (2)


18. Energy and the Environment (3)


18V. Energy and the Environment (3)

Web virtual lecture—1.5 hours; web electronic discussion—1.5 hours. Conventional and alternative energy resources and their environmental impacts. Basic principles, historical development, current advantages and disadvantages, future prospects. GE credit: SciEng | SE, SL, WE —W, W, J Vermeij

20. Geology of California (2)

Lecture—2 hours. 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. GE credit: SciEng | SE, SL, VL —W. (W), Vermeij

25. Geology of National Parks (3)

Lecture—3 hours. 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. GE credit: SciEng | SE, SL, VL —F. (F), Olsger

25V. Geology of National Parks (3)

Web virtual lecture—1 hour; web electronic discussion—2 hours. 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. Not open for credit to students who have completed course 25G. GE credit: SciEng | SE —S. (S.) Olsger (UC Santa Cruz), Schwarz (UC Santa Cruz)

28. Astrobiology (3)

Lecture—3 hours. 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. GE credit: SciEng|SE, SL, SL-F, SL-W.

30. Fractals, Chaos and Complexity (3)

Lecture/discussion—3 hours. Prerequisite: Mathematics 16A or 21A. 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. (Same course as Physics 30.) Offered in alternate years. GE credit: SciEng|Q|L, SE.—(W) Rundle

32. Volcanoes (3)

Lecture—3 hours. Role of eruptions, and eruptive products of volcanoes in shaping the planet's surface, interactions with the atmosphere, and issues of sustainability. GE credit: SciEng|SE.—S. (J) Cooper

35. Rivers (3)

Lecture—3 hours. 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 trip. GE credit: SciEng|SE, SL-W, W.-W.

36. The Solar System (4)


50. Physical Geology Laboratory (3)

Lecture—3 hours. Prerequisite: high school physics and chemistry. The Earth, its materials, its internal and external processes, its development through time by sea/land spreading and global plate tectonics. Students with credit for course 1 or the equivalent may receive only 2 units for course 50. GE credit: SciEng|SE, SL-F, W. (F, W) Billen, Cooper, Lesher, Zierenberg

50L. Physical Geology Laboratory (2)

Laboratory—6 hours. Prerequisite: course 50 concurrently. Introduction to classification and recognition of minerals and rocks to interpretation of tectonic and geologic maps and aerial photographs. Students with credit for course 1L or the equivalent may receive only 1 unit for course 50L. GE credit: SciEng|SE—F, W. (F, W) Billen, Cooper, Lesher, Zierenberg

60. Earth Materials: Introduction (4)

Lecture—3 hours; laboratory—3 hours. Prerequisite: Chemistry 2A; Mathematics 16A or 17A or 21A; course 1 or 50; course 50L. Physical and chemical properties of rocks, minerals and other earth materials; structure and composition of rock-forming minerals; formation of minerals by precipitation from fluids and solutions. GE credit: SciEng|L, SE—F, W. (F) Hill, McClain

62. Optical Mineralogy (2)

Lecture—1 hour; laboratory—3 hours. Prerequisite: course 60 can be concurrent. Optical properties of inorganic crystals; techniques of mineral identification using the polarizing microscope; strategies for studying rocks in thin section. GE credit: SciEng|SE—F, W. (F) F.

81. Learning in Science and Mathematics (2)

Lecture/discussion—2 hours; field work—2 hours. Limited to 26 students per section. 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. (Same course as Education 81.) GE credit: SS, VL, WE.—F, W, S, W, S (W) Latimer, Stevenson

91. Geology of Campus Waterways (1)

Lecture/discussion—1 hour; fieldwork—1 hour. Research characterizing geological processes on waterways on and off campus, including links among hydrologic, atmospheric, physical, and human processes; carbon cycling and interpreting processes from sediments; field research projects, design and implementation; implications of results for society and environmental policy. May be repeated for credit three times. (P/NP grading only.) GE credit: SE—F, W, S, F, W, S, W, S.

92. Internship (1-12)

Internship—3-36 hours. Prerequisite: consent of instructor; lower division standing. Work-experience opportunity ranging from off and on campus in all subject areas offered by the department, supervised by a member of the faculty. May be repeated for credit up to 12 units. (P/NP grading only.) GE credit: SE—F, W, S, W, S, W, S.

98. Directed Group Study (1-5)

Prerequisite: consent of instructor. May be repeated for credit up to three times. (P/NP grading only.) GE credit: SE—F, W, S, W, S, W, S.

99. Special Study for Undergraduates (1-5)

Prerequisite: consent of instructor; lower division standing. GE credit: SE—F, W, S, W, S, W, S.

Upper Division

101. Structural Geology (3)

Lecture—3 hours. Prerequisites: courses 50 and 50L; Physics 7A or 9A; Mathematics 16A or 17A or 21A; consent of instructor. Class size limited to 35 students. Study of rocks 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. GE credit: SciEng|SE—W. (W) Cowgill, Oskin

101L. Structural Geology Lab (2)

Laboratory—6 hours; fieldwork—2 hours. Prerequisites: courses 50 and 50L; Physics 7A or 9A; course 101 concurrently; consent of instructor. Class size limited to 15 students per session. 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. GE credit: SciEng|SE, VL—W. (W) Cowgill, Oskin

102. Field Geology (3)

Fieldwork; laboratory; Prerequisite: courses 101 and 110L; consent of instructor. Field mapping projects and writing geological reports. Weekly classroom meetings devoted to preparation of maps, cross sections, stratigraphic interpretations, and reports. Seven-eleven days on weekends during quarter. GE credit: SciEng|SE, VI, WE.—S. (J) Cowgill, Lesher

105. Earth Materials: Igneous Rocks (4)

Lecture—2 hours; laboratory—6 hours. Prerequisites: courses 60, 62; Mathematics 16A or 17A; Chemistry 28 (can be concurrent). Origin and occurrence of igneous rocks. Laboratory exercises emphasize the study of these rocks in hand specimen and thin section. GE credit: SciEng|Wrt|SE, VI, WE.—W. (W) Cowgill, Lesher

106. Earth Materials: Metamorphic Rocks (4)

Lecture—2 hours; laboratory—6 hours. Prerequisite: course 105. Physical and chemical properties of metamorphic rocks; interpretation of metamorphic environments. Laboratory exercises emphasize the study of these rocks in thin section. GE credit: SciEng|Wrt|SE, VI, WE.—S. (J) Lesher

107. Earth History: Paleobiology (3)


107L. Earth History: Paleobiology Laboratory (2)

Laboratory—5 hours. Prerequisites: courses 3 and 3L or Biological Sciences 2B; course 107 concurrently. Exercises in determining the ecological functions and evolution of individuals, populations, and communities of fossil organisms in field and laboratory. GE credit: SciEng|SE—F, W, S, F, W, S, F, S (J) Carlson, Matani

108. Earth History: Paleoclimates (3)

Lecture—3 hours. Prerequisite: course 1 or 50 or 116N or Environmental Science and Policy 116N; Chemistry 7A; consent of instructor. Introduction to 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. GE credit: SciEng|Wrt|SE, VI, SL, WE.—S. (J) Spero, Mancini

109. Earth History: Sediments and Strata (2)

Lecture—2 hours. Prerequisites: courses 50, 50L. Principles of stratigraphic and sedimentologic analysis. Evaluation of historical and modern global changes in sedimentation within terrestrial and marine environments. Examination of the plate tectonic, clastic and oceanographic factors controlling the distribution and exploitation of economic fluids within sedimentary rocks. GE credit: SciEng|SE—W. (W) Summer

109L. Earth History: Sediments and Strata Laboratory (2)

Laboratory—5 hours. Prerequisite: course 109 concurrently. 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 course 109. Includes four one-day field trips. GE credit: SciEng|Wrt|SE, VI, WE.—W. (W) Summer

110. Summer Field Geology (8)

Fieldwork; Prerequisite: course 103, course 109; course 103 recommended. Advanced application of geologic and geophysical field methods to studying rocks. Includes development and interpretation of geologic maps and cross sections; gravity, magnetic, teleseismic and seismic surveys; and field analysis of plutonic and volcanic rock suites. Eight hours/day, six days/week for six weeks. GE credit: SciEng|Wrt|SE, VI, WE, SL—Su. (J) Oskin, Cowgill

115. Earth History: Science & Policy (4)

Lecture—3 hours; discussion—1 hour. Prerequisite: upper division standing; course 1. Study of interplay between the Earth and its human inhabitants through history, including consideration of acute events such as mass extinctions and the impact of environmental degradation on resources, topography, and water. GE credit: SciEng|Sci|Wrt|OL, WE, WE.—S. (J) Verosub

116N. Oceanography (3)

Lecture—2 hours; laboratory—2 hours; field work. Prerequisite: course 1 or 2 or 50 or 50L. Basic oceanographic topics: Chemical, physical, geologic, and biological processes; research methods and data analysis; marine resources, anthropogenic impacts, and climate change. Includes ocean/atmosphere systems; weekly lab and one weekend field trip. [Same course as Environmental Science & Policy 116N.] Offered in alternate years. GE credit: SciEng|SE, VI, WE—W. (W) Hill, Collard

120. Origins: From the Big Bang to Today (3)

Lecture—3 hours. Limited enrollment. Long-term and large-scale perspectives on the origins of the universe, stars and planets, and the evolution, the rise of civilization and the modern world. Multidisciplinary approach to 'Big History' involving cosmology, astronomy, geology, climatology, biology, anthropology, archeology, and history. GE credit: SciEng|SE.—S. (J) Osleger
130. Non-Renewable Natural Resources (3)
Lecture—3 hours. Prerequisite: course 1 or 50. Origin, occurrence, and distribution of nonrenewable resources, including metallic, nonmetallic, and energy-producing materials. Problems of discovery, production, and management. Estimations and limitations of resources and their social, political, and economic effects. Offered in alternate years. GE credit: SciEng | SE, SL. —F. (F.) Versus

131. Risk: Natural Hazards and Related Phenomena (3)

132. Introductory Inorganic Geochemistry (3)
Lecture—3 hours. Prerequisite: course 60 (can be concurrent); Chemistry 2B. 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, geochronological cycles. Offered in alternate years. —F. Yin

134. Environmental Geology and Land Use Planning (3)
Lecture—3 hours. One course in Geology or course 1 or course 50; consent of instructor. Geologic aspects of land use and development planning. Geologic problems concerning volcanic and earthquake hazards, land stability, floods, erosion, coastal hazards, nonrenewable resource extraction, waste disposal issues. GE credit: SciEng, Wrt | SE, WE. —W. (W.) Pinter

136. Ecogeomorphology of Rivers and Streams (5)
Lecture—1 hour; discussion/lab—2 hours; fieldwork—1 hour or paper or discussion. Prerequisite: upper division or graduate standing in any physical science, biological science, or engineering, and consent of instructor. Restricted to advanced students in the physical sciences, biological sciences, or engineering. 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. GE credit. GE credit: SciEng | SE, WE. —S. (S.) Pinter

138. Introductory Volcanology (4)
Lecture—2 hours; fieldwork—6 hours. Prerequisite: course 60 and 109; consent of instructor. Principles of physical and chemical volcanology. Taught in a volcanically active setting (e.g., Hawaii) with a strong field component. GE credit: SciEng | SE. —F. (F.) Zierenberg

139. Rivers: Form, Function and Management (4)
Lecture—3 hours; fieldwork—3 hours. Prerequisite: course 50 or 50L; Mathematics 168 or 218 recommended. Analysis of river form and processes, emphasis on fluvial geomorphology, and river and stream restoration techniques to illustrate concepts and applications. Two weekend field trips required. Offered in alternate years. GE credit: SciEng | SE. —F. Pinter

140. Introduction to Process Geomorphology (4)
Lecture—3 hours; laboratory—3 hours. Prerequisite: course 1 or 50; Mathematics 168 or 218. Quantitative description and interpretation of landscapes with emphasis on the interplay between physical processes, mass conservation, and landform evolution. Topics covered include physical and chemical weathering, hillslopes, debris flows, fluvial systems, alluvial fans, glacial landforms, processes of subaerial and Quaternary geomorphology. Offered in alternate years. —(F.) Osokin, Pinter

141. Evolutionary History of Vertebrates (3)
Lecture—3 hours. Prerequisite: course 3 or Biological Sciences 2A. Evolutionary history of vertebrates; fossil record and phylology; timing of major evolutionary events; appearance of major vertebrate groups; phylogenetic evolution; paleobiogeography of vertebrates; effect of continental movement on vertebrate evolution; dinosaurs and other strange vertebrates. Offered in alternate years. GE credit: SciEng | SE. —W. (W.) Motani

141L. Evolutionary History of Vertebrates Laboratory (1)
Laboratory—3 hours. Prerequisite: course 141 (can be concurrent). Augments lecture course 141 through handling of in-person examination of three dimensional features observed in vertebrate skeletons, both fossil and living. Offered in alternate years. GE credit: SciEng | SE. —W. (W.) Motani

142. Basin Analysis (3)
Laboratory—3 hours; lecture—2 hours. Prerequisite: courses 50, 50L, and 109. 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 in alternate years. GE credit: SciEng | SE. —V. —L. —W. (W.) Pinter

143. Advanced Igneous Petrology (5)
Lecture—3 hours; laboratory—6 hours. Prerequisite: course 105; Mathematics 16C or 21C, Chemistry 2C. Physical and chemical properties of magmatic environments and processes of igneous rock formation. Laboratory-intensive study of analytical igneous rocks. Offered in alternate years. GE credit: SciEng, Wrt | SE. —S. (S.) Cooper, Lasher

144. Historical Ecology (3)
Lecture—3 hours. Prerequisite: upper division course in environmental science or ecology, or an introductory course in paleobiology. 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. GE credit: SciEng | SE, WE. —W. (W.) Yeremjev

145. Advanced Metamorphic Petrology (5)
Lecture—3 hours; laboratory—6 hours. Prerequisite: course 106; Hydrologic Science 134 or Chemistry 2C, Mathematics 16C or 21C. Metamorphic processes and the origin of metamorphic rocks. Laboratory study of representative metamorphic rocks. Offered in alternate years. GE credit: SciEng, Wrt | SE. —L. (L.) Lasher

146. Radiogenic Isotope Geochemistry and Cosmochemistry (3)
Lecture—3 hours. Prerequisites: Chemistry 2C, Physics 7C, and Mathematics 16C. Basic principles of nuclear chemistry and physics applied to geology to determine the ages of terrestrial rocks, meteorites, archaological objects, age of the Earth, to trace geochemical processes, and explain formation of the chemical elements in the Universe. Offered in alternate years. GE credit: SciEng | QL, SE, —F. (F.) Yeremjev

147. Geology of Ore Deposits (4)
Lecture—3 hours; laboratory—3 hours; optional one-weekend field trip. Prerequisite: Chemistry 2C or Hydrologic Science 134, courses 60, 62, and 105. Tectonic, lithologic and geochemical setting of major metallic ore deposits emphasizing ore deposit genesis, water/rock interaction and the environmental effects of mining. Offered in alternate years. GE credit: SciEng | QL, SE, —F. (F.) Zierenberg

148. Stable Isotopes and Geochemical Tracers (3)
Lecture—3 hours. Prerequisites: Chemistry 2C or Hydrologic Science 134; courses 50, 50L, 60. 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 in alternate years. GE credit: SciEng | QL, SE. —S. —Zierenberg

149. Geothermal Systems (3)
Lecture—3 hours; fieldwork. Prerequisite: courses 50 and 50L; Chemistry 2B; Geology, geochemistry, and geophysics of geothermal systems, including electric power generation and water/rock interaction. Includes one day field trip on a weekend during the quarter. GE credit: SciEng | SE. —W. (W.) Zierenberg

150A. Physical and Chemical Oceanography (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: course 116N or Environmental Science and Policy 116N; Physics 98B, Mathematics 21D, Chemistry 2C; consent of instructor. Physical and chemical properties of seawater, fluid dynamics, air-sea interaction, currents, waves, tides, mixing, major oceanic geochemical cycles. (Same course as Environmental Science and Policy 150A). GE credit: SciEng | QL, SE. —F. (F.) McClain, Spero

150B. Geological Oceanography (3)
Lecture—3 hours. Prerequisite: course 50 or course 116N or Environmental Science and Policy 116N. Introduction to the origin and evolution of ocean basins. Composition and structure of ocean crust; marine volcanism; and deposition of marine sediments. Interpretation of geologic history of the ocean floor in terms of sea-floor spreading theory. (Same course as Environmental Science and Policy 150B.) GE credit: SciEng | SE. —W. (W.) McClain

150C. Biological Oceanography (4)
Lecture—3 hours; discussion—1 hour; fieldwork. Prerequisite: Biological Sciences 2A; a course in general ecology. Ecology of major marine habitats, including intertidal, shelf benthic, deep-sea and planktonic communities. Existing knowledge and contemporary issues in research. Segment devoted to human use. Offered in alternate years. GE credit: SciEng | SE.—Hill

156. Hydrogeology and Contaminant Transport (5)
Lecture—3 hours; laboratory—3 hours; term paper. Prerequisites: Hydrologic Science 145; courses 50, 50L, and 109. Physical and chemical processes affecting groundwater flow and contaminant transport, with emphasis on realistic hydrogeology. Groundwater geology and chemistry. Fundamentals of groundwater flow and transport analysis. Laboratory includes field pumping test and work with physical and computer models. (Same course as Hydrologic Science 146.) GE credit: SciEng | SE. —W. (W.) Fogg

160. Geological Data Analysis (3)
Lecture/discussion—3 hours. Prerequisite: Mathematics 21A. Introduction to quantitative methods in analyzing geological data, covering principles of statistics and probability, error analysis, hypothesis testing, inverse theory, time series analysis and directional data analyses. Use of computer in lectures and homework. GE credit: SciEng | QL, SE. —W. (W.) Rundle

161. Geophysical Field Methods (3)
Lecture/discussion—3 hours; term paper. Prerequisite: course 1 or 50; Mathematics 21C, Physics 7C or 70; consent of instructor. Physical methods applied to determining subsurface structure in tectonics, hydrogeology, geotechnical engineering, hydrocarbon and mineral exploration. Theory, survey design and interpretation; gravity, electrical resistivity, electromagnetic, reflection and refraction, and ground penetrating radar measurements. GE credit: SciEng | QL, SE. —F. (F.) Billen
162. Geophysics of the Solid Earth (3)
Lecture—3 hours. Prerequisite: Mathematics 21C; Physics 7C or Physics 9C; consent of instructor. Theory of use of physics in the study of the solid Earth. Gravity, magnetism, paleomagnetism, and heat flow. Application to the interpretation of the regional and tectonically dynamic aspects of the earth and to plate tectonics. Offered in alternate years. GE credit: SciEng|Q|L, SE.—[W|J] Kellogg

163. Planetary Geology and Geophysics (3)
Lecture—3 hours. Prerequisite: Mathematics 21C; Physics 7C or Physics 9C; course 50 or course 26 or Astronomy 10G or Astronomy 10L or Astronomy 10S; consent of instructor. Principles of planetary science, emphasizing the Moon, Mercury, Venus, Mars, and Pluto, including orbital mechanics, tidal interactions and ring dynamics. Theory of planetary interiors, gravitational fields, rotational dynamics. Physics of planetary atmospheres. Geological processes, landscapes, and their modification. Methods of analysis from Earth-based observations and spaceflight. Offered in alternate years. GE credit: SciEng|Q|L, SE.—[W|J] Yin

175. Advanced Field Geology (3)
Discussion—3 hours; fieldwork—6 hours. Prerequisite: consent of instructor. Advanced field studies of selected geologic terrains, interpretation and discussion of field observations. May be repeated two times. Departmental approval when instructors vary. (P/NF grading only.) GE credit: SE.—Cooper, Roesser

181. Teaching in Science and Mathematics (2)
Lecture/discussion—2 hours; fieldwork—2 hours. Prerequisite: major in mathematics, science, or engineering; or consent of instructor. Survival science for a one-year sequence in science or calculus and consent of the instructor. Class size limited to 40 students per section. 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. (Same course as course 181.) (P/NF grading only.) GE credit: SS; WE.—F, W, S; F, W, S; J) Horn

182. Field Studies in Marine Geochorgraphy (2-8)
Lecture—3 hours; laboratory—1-3 hours; fieldwork—6-40 hours. Prerequisite: consent of instructor. Marine geochorography 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 analysis of data/samples collected. GE credit: SciEng|SE.—Hill

183. Teaching High School Mathematics and Science (3)
Lecture—2 hours; fieldwork—2 hours. Prerequisite: course 81/Education 81 or course 181/Education 181 and major in mathematics, science, or engineering, or completion of a one-year sequence in science or calculus and consent of the instructor. Limited to 40 students per section. Development of the creation of effective teaching practices based on examination of how high school students learn mathematics and science. Field experience in high school classrooms. (Same course as Education 183.) GE credit: SocSci|OL, SS, WE.—F, W, S; (F, W, S) Finter, Stevenson

190. Seminar in Geology (1)
Discussion—1 hour, seminar—1 hour. Presentation and discussion of current topics in geology by visiting lecturers, staff, and students. Written abstracts may be required for credit. (P/NF grading only.) GE credit: SciEng|SE.—W. (W.) Spero

192. Internship in Geology (1-12)
Internship. Prerequisite: upper division standing; project approval prior to internship. Supervised work experience in geology. May be repeated for credit for a total of 110 units. (P/NF grading only.) GE credit: SS.—F, W, S; (F, W, S, J) Kellogg

194A. Senior Thesis (3)
Prerequisite: open to Geology majors who have completed 135 units and who do not qualify for the honors program. Guided independent study of a selected topic, leading to the writing of a senior thesis. (Deferred grading only, pending completion of course sequence.) GE credit: SciEng|SE, WE.—F, W, S; (F, W, S)

194B. Senior Thesis (3)
Prerequisite: open to Geology majors who have completed 135 units and who qualify for the honors program. Guided independent study of a selected topic, leading to the writing of a senior thesis. (Deferred grading only, pending completion of sequence.) GE credit: SciEng|SE, WE.—F, W, S; (F, W, S)

194HA. Senior Honors Project (3)
Independent study—9 hours. Prerequisite: open to Geology majors who have completed 135 units and who qualify for the honors program. Guided independent study of a selected topic, leading to the writing of an honors thesis. (Deferred grading only, pending completion of sequence.) GE credit: SciEng|SE, WE.—F, W, S; (F, W, S)

194HB. Senior Honors Project (3)
Independent study—9 hours. Prerequisite: open to Geology majors who have completed 135 units and who qualify for the honors program. Guided independent study of a selected topic, leading to the writing of an honors thesis. May be repeated for credit. Offered in alternate years. (P/NP grading only.) GE credit: SciEng|SE, WE.—F, W, S; (F, W, S)

198. Directed Group Study (1-5)
Prerequisite: major in mathematics, science, or engineering; or completion of a one-year sequence or calculus and consent of the instructor. GE credit: Science and Engineering; WE.—Oskin, Sumner

199. Special Study for Advanced Undergraduates (1-5)
Prerequisite: senior standing in Geology or consent of instructor. (P/NF grading only.) GE credit: SciEng|SE.—F, W, S; (F, W, S)

Graduate

205. Advanced Field Stratigraphy (3)
Lecture—1 hour; field work—2 hours. Prerequisite: courses 109 or 109L and consent of instructor; course 206 recommended. Fieldwork over spring break. Application of stratigraphic techniques to research problems. Collection, compilation, and interpretation of stratigraphic data with models for deposition and interpretations of Earth history. Topics will vary. May be repeated for credit. Offered in alternate years. (S. J) Sumner

206. Stratigraphic Analysis (3)
Lecture—3 hours. Prerequisite: courses 109, 109L or consent of instructor; course 214 recommended. Topics in advanced methods of stratigraphic analysis, regional stratigraphy and sedimentation, and sedimentary basins. Application of techniques used to interpret stratigraphic record and on current issues in stratigraphy and sedimentation. May be repeated for credit when topics differ. Offered in alternate years. (W, W) Cagg, Oskin

214. Active Tectonics (3)
Lecture/discussion—3 hours. Prerequisite: graduate standing or consent of instructor. 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 for deformation. Offered in alternate years. (S. J) Oskin

216. Tectonics (3)
Lecture/discussion—3 hours. Prerequisite: course 101 or consent of instructor. 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 in alternate years. (W, W) Cagg

217. Topics in Geology (1-5)
Lecture—1 hour; seminar—2 hours. Prerequisite: consent of instructor. Discussion and evaluation of current research in a given area of geophysics. Topics will change from year to year. May be repeated for credit. Offered in alternate years. (F, S; F, J) Billen, Kellogg, McClain

218. Analysis of Structures in Deformed Rocks (3)
Seminar—3 hours. Prerequisite: courses 100, 100L, 101, 101L, 170, or consent of instructor. Recent advances in the understanding and analysis of structures in deformed rocks. Detailed investigations of the mechanical and kinematic characteristics of the structures, models for their formation, and applications to inferring the kinematics of large scale tectonics. Offered in alternate years. (W, W) Cagg

219. Fracture and Flow of Rocks (3)
Lecture—3 hours. Prerequisite: courses 100, 100L, Mathematics 21 or 16, Physics 7 or 9, or consent of instructor. Origins of those structures in rocks associated with brittle and ductile deformation. Theoretical analysis of the use of crack mechanics and experimental evidence for the origin of the structures with emphasis on deformational processes in the earth. Offered in alternate years. (S. J) Billen

220. Mechanics of Geologic Structures (3)
Lecture—3 hours. Prerequisite: course 170, Mathematics 21C, Physics 9A or 9A, or consent of instructor; Mathematics 21D and 22A recommended. 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, dike, folds, foliations, and jointing. Offered in alternate years. (W, W) Cagg

222. Advanced Sedimentary Petrology (3)
Lecture—2 hours; laboratory—3 hours. Prerequisite: course 144 or consent of instructor. Advanced petrography and geochemistry of sediments and sedimentary rocks. Geochronology and mineralogical evolution of sedimentary rocks reflecting depositional or burial processes. Laboratory work emphasizes thin section petrography. May be repeated for credit when topics differ. Offered in alternate years. (W) Sumner

227. Stable Isotope Biogeochorgraphy (4)
Lecture—2 hours; laboratory—6 hours. Prerequisite: graduate standing and consent of instructor. Discussion and application of stable isotope techniques for scientific research problems. Course emphasizes carbon, oxygen, nitrogen, hydrogen and sulfur isotopes. Laboratory work emphasizes thin section petrography. May be repeated for credit. Offered in alternate years. (W, W) Cagg

230. Geomorphology and River Management (1-3)
Seminar—3 hours. Prerequisite: graduate standing, course 139 or equivalent. Impacts of management and land use activities on the geomorphology of rivers and streams. Evaluation and use of analytical tools for river assessment of river and stream restoration strategies and emerging issues in river management. May be repeated for credit when topics differ. Offered in alternate years. (W) Pinter

232. The Oceans and Climate Change (3)
Lecture—2 hours; discussion—3 hours. Prerequisite: courses 105, 150A or consent of instructor. Current understanding of role of ocean circulation throughout the geologic record. Impacts of ocean circulation on the atmosphere and climate. Important ocean-atmosphere interactions. The role of ocean circulation in climate change. GE credit: Science and Engineering; WE.—W. (W.) Pinter

233. Surface Processes andr Rivers (3)
Seminar—3 hours. Prerequisite: courses 50, 50L, 139; Mathematics 218 or 168 recommended. 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 evolu-
tion. Offered by credit when topic differs. Offered in alternate years. —S. (S.) Oskin

236. Inverse Theory in Geology and Geophysics (3)
Lecture—3 hours. Prerequisite: consent of instructor. Inversion of parameters. Evaluation of parameter uncertainties. Linear and nonlinear problems for discrete and continuous models. Elastic wave propagation in stratified media. Offered in alternate years. [F/NP grading only.] —S. (S.) McClain

238. Theoretical Seismology (3)
Lecture—3 hours. Prerequisite: consent of instructor. Elastodynamic wave equation. Greens functions and source representations. Ray theory. Plane and spher-
ical waves and geometrical spreading. Elastic wave propagation in stratified media. Offered in alternate years. [F/NP grading only.] —S. (S.) McClain

240. Geophysics of the Earth (3)
Lecture—3 hours. Prerequisite: Earth Sciences and Resources 201, Physics 98B, Mathematical 228. 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. Travel times and surface seismic waveforms. Equations of state, thermal structure of the earth. Offered in alternate years. —S. (S.) Kellogg

241. Geomagnetism (3)
Lecture—3 hours. Prerequisite: graduate standing. Nature and control of the Earth’s magnetic field. Present field and recent secular variation. Spherical har-
monic analysis. Paleosecular variation. Polarity transitions and geomagnetic excursions. Statistics of polarity intervals. Dynamic theory. Paleomagnetic me-
trics. Offered in alternate years. —F. (F.) Verslob

242. Paleomagnetism (3)

246. Physical Chemistry of Metamorphic Processes (3)
Lecture—3 hours. Prerequisite: course 145, Chemistry 110A or consent of instructor. Physiochemical principles of metamorphic mineral assemblages and methods of interpreting the paragenesis of metamor-
phic rocks. Offered in alternate years.

247. Metamorphic Petrology Seminar (3)
Seminar—3 hours. Prerequisite: course 145 or consent of instructor; course 246 recommended. Selected topics in metamorphic petrology (e.g., mass transport processes, tectonic settings, geother-
ometry). Tentative schedule: (1) metamorphic belts, regional studies). May be repeated for credit when topic differs. (S/U grading only.) Offered in alternate years.

250. Advanced Geochemistry Seminar (3)
Seminar—3 hours. Prerequisite: course 145 or consent of instructor. Critical review of selected topics in geochemistry including: ore genesis, hydrothermal and geothermal fluids, recent and ancient sediments, isotopic geochemistry (e.g., stable isotopes in meteorites, planetary sciences, and geochemistry). Subject varies yearly depending on student interest. May be repeated for credit. Offered in alternate years. —S. (S.) Cooper, Zierenberg

251. Advanced Topics in Isotope Geochemistry and Cosmochemistry (3)
Lecture/discussion—2 hours, term paper. Prerequisite: graduate standing or consent of instructor. Astrophyiscal context on origin of Solar System, syn-
thesis of chemical element condensation sequence, star and planet formation, cosmochemistry, build-
ing blocks of planets, development of planets on layersed structure, atmosphere and hydrosphere and the role of comets/asteroids for volatile delivery. May be repeated for credit when topic differs. Offered in alternate years. —W. (W.) Yin

253. Current Topics in Igneous Petrology (3)
Seminar—3 hours. Prerequisite: graduate standing in Geology; course 143 or consent of instructor. Topical seminar designed to help graduate student develop and maintain familiarity with current and past literature related to igneous rock petrogenesis. May be repeated for credit when topic differs. (S/U grading only.) —F. (F.) Cooper, Lesher

254. Physical Chemistry of Igneous Processes (3)
Lecture—3 hours. Prerequisite: course 143 or consent of instructor; Chemistry 110A required, Chemistry 110B and 110C recommended. Emphasis on modern concepts in chemical thermodynamics and kinetics, and fluid dynamics of magmatic systems for graduate students in petrology. Offered in alternate years. —Lesher

255. Experimental Petrology (3)
Lecture—2 hours; laboratory—3 hours. Prerequisite: course 143 or consent of instructor. Introduction to techniques and methods of design and executing experiments on Earth minerals and rocks. Problems and examples from igneous and metamorphic petrology will be utilized. Offered in alternate years. —Roeske

260. Paleontology (3)
Seminar—3 hours. Prerequisite: graduate standing in geology or a biological science. Selected prob-
lems in paleontology. Subject to be studied will be decided at an organizational meeting. May be repeated for credit when topic differs. Offered in alternate years. —F. (S.) Vermeij

261. Paleobiology Graduate Seminar: Evolutionary aspects (3)
Lecture—1 hour; seminar—2 hours. Prerequisite: graduate standing in Geology or a biological sci-
cence; qualified undergraduates accepted on an exception-only basis. This course will treat one or more of several topics in paleobiology from a phylo-
genetic perspective, including major patterns in evo-
luon, building the tree of life, extinction and phylogeny, phylogeny of major phyla, and the rela-
tion between taxonomy and phylogeny. May be repeated for credit when topic varies. Offered in alternate years. —F. (S.) Vermeij

262. Paleobiology Graduate Seminar: Methodological Aspects (3)
Lecture—1 hour; seminar—2 hours. One or more major methods used in the study of fossils: Morpho-
metrics and three-dimensional reconstruction of fos-
sils, phylogenetic methodology, the application of geochemical techniques, and electron microscopy. May be repeated for credit when topic varies. Offered in alternate years. —S. (S.) Matani

281N. Instrumental Techniques for Earth Scientists (3)
Lecture—2 hours; laboratory—3 hours. Prerequisite: Mathematics 21A, 21B, 21C, Physics 7A, 7B, 7C or 9A, 9B, 9C or consent of instructor. Laboratory research techniques for new graduate students in Geology. Demonstration of and exposure to appro-
riate techniques. May be repeated for credit when topic varies. Offered in alternate years. —S. (S.) Spero, Yin

285. Field Studies in Marine Geochemistry (2-8)
Lecture—3 hours, laboratory—1-3 hours; field-
work—6-40 hours. Prerequisite: consent of instructor. 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 reduc-
tion and sample analysis. Analysis of data/samples collected. —Hill

290. Seminar in Geology (1)
Seminar—1 hour; discussion—1 hour. Presentation and discussion of current research in geology by visit-
ing lecturers, staff, and students. (S/U grading only.) —F. W. S. (F. W. S.)

291. Geology of the Sierra Nevada (1)
Seminar. Prerequisite: consent of instructor. Short-
oral presentations by students and faculty con-
cluding results of their past work and plans for future work in the Sierra. A written abstract is required fol-
lowing the format required at professional meetings. (S/U grading only.) Offered in alternate years. —S. (S.)

292. River Forum (1)
Seminar—1 hour. Prerequisite: graduate standing. Review and discussion of latest research and funda-
mental issues surrounding river processes. May be repeated for credit when topic differs. (S/U grading only.) Offered in alternate years. —F. W. S. (F. W. S.)

293. Geologic Event of the Week (1)
Discussion—0.5 hours; seminar—0.5 hours. Prere-q uisite: graduate standing. Seminar/discussion group to review and discuss recent earthquakes, volcanic eruptions, and other significant geologic events. The focus is on understanding the available observa-
tions, the physical processes behind each event, the geological setting, and societal consequences. May be repeated for credit three times for up to three units. (S/U grading only.) Offered in alternate years. —F. W. S. (F. W. S.) Kellogg

294. Structure/Tectonics Forum (1)
Seminar—1 hour. Prerequisite: graduate student in geology or consent of instructor. Seminar/discussion group to review and discuss latest research in struc-
tural 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. May be repeated for credit when topic differs. (S/U grading only.) Offered in alternate years. —F. W. S. (F. W. S.)

295. Advanced Problems in Geodynamics (3)
Seminar—3 hours. Prerequisite: courses 100 and 101 or consent of instructor. Seminar dealing with problems in geodynamics. Topics will vary (e.g., ductile deformation mechanisms, brittle fracture, earthquake prediction, driving forces for plate tec-
tonics, mantle convection). Emphasis on recent litera-
ture. May be repeated for credit when topic differs. (S/U grading only.) Offered in alternate years. —F. W. S. (F. W. S.)

296. Advanced Problems in Tectonics (3)
Seminar—3 hours. Prerequisite: course 101 or con-
sent of instructor. Seminar dealing with current prob-
lems in tectonics of selected regions. Topics will change from year to year. Emphasis on study of recent literature. May be repeated for credit. (S/U grading only.) Offered in alternate years. —F. (F.) Cowgill

297. Geophysics Forum (1)
Seminar—0.5 hours; discussion—0.5 hours. Prere-
quise: graduate student status in the Geology Depart-
ment, or consent of instructor. Seminar/discussion group to review and discuss latest research in geo-
physics, and on-going research of participants. Top-
ics will change each quarter depending on the interests of the group. May be repeated three times for credit. (S/U grading only.) Offered in alternate years. —F. W. S. (F. W. S.)

298. Group Study (1-5)
Prerequisite: graduate standing or consent of instruc-
tor. May be repeated up to 10 units for credit. (S/U grading only.) Offered in alternate years. —F. W. S. (F. W. S.)

299. Research (1-12)
(S/U grading only.) —F. W. S. (F. W. S.)

Professional

300. Methods of Teaching Geology (2)
Extensive writing or discussion—2 hours. Prerequi-
site: graduate student standing in Geology. Introduc-
tion to graduate-level writing and undergraduate-
level teaching skills in geology. Persuasive (proposal) writing workshop, discussions on campus teaching resources, presenting information, managing class-
room dynamics, evaluating student performance. Participation in teaching project (with permission of Ph. D. in Geology. (S/U grading only.) —F. (F.) Billen
Earth Sciences

See Earth and Planetary Sciences, on page 237; Environmental and Resource Sciences, on page 323; Hydrologic Sciences (A Graduate Group), on page 376; Hydrology, on page 376; and Soil Science, on page 531.

East Asian Languages and Cultures

(Faculty of Arts and Science)
Michelle Yeh, Ph.D., Chairperson of the Department

Department Office, 211 Sproul Hall
530-752-4999
http://chinese.ucdavis.edu;
http://japanese.ucdavis.edu

Faculty
Chia-niung Chang, Ph.D., Professor (Japanese)
Xiaomei Chen, Ph.D., Professor (Chinese)
Chengzhi Chu, Ph.D., Associate Professor (Chinese)
Michael Foster, Ph.D., Assistant Professor (Japanese)
David Gundry, Ph.D., Associate Professor (Japanese)
Mark Halperin, Ph.D, Associate Professor (Chinese)
Yuming He, Ph.D., Associate Professor (Chinese)
Nobuko Koyama, Ph.D., Assistant Professor (Japanese)
Joseph Sorensen, Ph.D., Associate Professor (Japanese)
Sayomi Suzuki, Ph.D., Assistant Professor (Japanese)
Michelle Wrigley, Ph.D., Professor (Chinese)

Emeriti Faculty
Robert Borgen, Ph.D, Professor Emeritus
Donald A. Gibbs, Ph.D., Professor Emeritus

Affiliated Faculty
Junjo Itô, Lecturer (Japanese)
Yoko Kato, Lecturer (Japanese)
Ichia Lee, Lecturer (Chinese)
Jiao Li, Lecturer (Chinese)
Ling-Yu Lu, Lecturer (Chinese)
Naoko McHale, Lecturer (Japanese)
Mayumi Saito, Lecturer (Japanese)
Haruko Sakakibara, Lecturer (Japanese)
Miyu Uchida, Lecturer (Japanese)
Mieko Watonabe, Lecturer (Japanese)
Miki Wheeler, Lecturer (Japanese)
Birbin Yang, Lecturer (Chinese)

The Major Program

The department offers a core language program in both Chinese and Japanese in courses and literature and culture. The core language program in Chinese has two tracks for students who have no background whatsoever and one for students with prior language background.

The Program.
A student elects to major in either Chinese or Japanese. Practical language skills are taught using the most modern methods so that upon entering the upper division a student will have attained substantial fluency in the spoken language (hearing and speaking) and the written language (reading and writing). Upper division courses balance the need to further language skills with the need to understand and appreciate the cultural richness of either Chinese or Japanese civilization. All students are encouraged to combine their study of language and literature with courses in related fields, and to study abroad through the Education Abroad Program, the UC Davis Study Abroad Program or through internships in China and Japan.

Career Opportunities.
UC Davis graduates have learned that a major in Chinese or Japanese is a genuine, earned distinction that facilitates entrance to graduate programs and professional schools. In addition, job opportunities abound in virtually all career paths, especially for those who have completed study abroad.

Chinese

A.B. Major Requirements:

Preparatory Subject Matter .................. 30

Chinese 1, 2, 3, 4, 5, 6; OR 18L, 28L, 38L; OR 1CN, 2CN, 3CN; OR equivalent as determined by a required language placement examination.

Recommended but not required:
Chinese 10, 11, 50, Comparative Literature 14, Japanese 10, Linguistics 1, History 9A.

Depth Subject Matter ...................... 40


Note: With prior approval of the undergraduate adviser, students already proficient in Chinese at any third-year level (111-112-113) must take other upper-division Chinese courses to replace language courses(s).

Three* courses (at least 12 units) selected from Chinese 100A, 101, 102, 103, 104, 105, 108, 109A, 110, 115, 116, 120**, 130**, 131, 132, 133**, 134, 140**, 150** or any approved substitutions; one of the three courses must be from Chinese 101, 102, 103, 104, 109G....12
**Chinese 120, 130, 133, 140 and 150 can be repeated when the contents are different.

Recommended substitutions: Japanese 101, 102, 103, 104, 105, 106; Anthropology 148A or 148B; Art History 163A or 163B; East Asian Studies 111; History 919A; Religious Studies 172; or other advanced literature and culture courses selected in consultation with the undergraduate adviser.

Total Units for the Chinese Major ........... 40-70

Major Advisers in Chinese.
X. Chen, C. Chu, M. Halperin, Y. He, M. Yeh

Japanese

A.B. Major Requirements:

Preparatory Subject Matter .................. 30

Japanese 1, 2, 3, 4, 5, 6 OR equivalent as determined by a required language placement examination.

Recommended but not required:
Japanese 10, 15, 25, Chinese 10, 11, 50, Linguistics 1, History 9B.

Depth Subject Matter ...................... 40


Note: With prior approval of the undergraduate adviser, students already proficient in Japanese at any third-year level (111-112-113) must take other upper-division Japanese courses to replace language courses(s).

Three classes (at least 12 units) selected from the following: Japanese 104, 105, 106, 107, 108, 109, 114A-C, 115, 121, 122, 123, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 152, 156, 157, Anthropology 149A, 149B; Art History 164; Chinese (up to two upper-division Chinese courses); Comparative Literature 153; Economics 171; History 194A, 194B, 194C; Political Science 148B, Religious Studies 170, 172; or other advanced literature and culture courses selected in consultation with the undergraduate adviser.

Total Units for the Japanese Major ...........40-70

Major Advisers in Japanese.
C. Chang, D. Gundy, N. Koyama, J. Sorensen

Minor Program Requirements:

Minors are offered in Chinese and in Japanese for students wishing to follow a formally recognized program of study in those languages and literatures.

Chinese

No units

Japanese

No units

All upper division courses, including both language courses and literature in translation courses, may be used to meet this requirement. One approved lower division course (Chinese 10, 11, 50; Japanese 10, 25, 50) may also be used. In addition, students must demonstrate their language proficiency, normally through completion of Chinese 38L or 6 or Japanese 6. Only four units from 192, 197, 198, and 199 may be applied to the minor. For details, consult the undergraduate advisers.

Honors Program.
Candidates for high or highest honors in Chinese or Japanese must enroll in Chinese 199 or Japanese 199 and complete a research project or a scholarly essay or a capstone experience under the direction of a faculty member. The project will have a minimum duration of two quarters and carry a minimum of 6 units of credit. Additionally, entrance into the honors program requires completion of at least 135 units with a minimum GPA of 3.500 in courses counted toward the major. Interested students should consult with faculty in their field of interest in their junior year and undertake their project during the first two quarters of their senior year. Other arrangements must be authorized in advance by the department chair.

Students who complete the honors thesis receive departmental citation, and if their overall GPA qualifies them, may be recommended by the faculty for honors, high honors or highest honors at graduation.

Education Abroad Program.
The university maintains study abroad programs in China, Japan, Hong Kong, and Taiwan. They offer excellent opportunities for students to further develop their language skills and experience Asian cultures firsthand. Students are encouraged to participate. Appropriate courses taken abroad can be applied toward the major or the minor.

Preparation.
For the department’s undergraduate adviser, the Education Abroad Program office or the UC Davis Study Abroad Office.

Related Courses.
See East Asian Studies course list.

Prerequisite Credit.
No student may repeat a course that is a prerequisite for a course that has already been completed with a grade of C– or better.

Placement.
Chinese 1 and Japanese 1 are intended for beginning students with no prior knowledge of those languages. Students who do not have some knowledge but wish to improve their skills should meet with one of the advisers to discuss appropriate placement.

Preparation.
For the department’s undergraduate adviser, the Education Abroad Program office or the UC Davis Study Abroad Office.

Related Courses.
See East Asian Studies course list.

Prerequisite Credit.
No student may repeat a course that is a prerequisite for a course that has already been completed with a grade of C– or better.

Placement.
Chinese 1 and Japanese 1 are intended for beginning students with no prior knowledge of those languages. Students who do not have some knowledge but wish to improve their skills should meet with one of the advisers to discuss appropriate placement.

Preparation.
For the department’s undergraduate adviser, the Education Abroad Program office or the UC Davis Study Abroad Office.

Related Courses.
See East Asian Studies course list.

Prerequisite Credit.
No student may repeat a course that is a prerequisite for a course that has already been completed with a grade of C– or better.

Placement.
Chinese 1 and Japanese 1 are intended for beginning students with no prior knowledge of those languages. Students who do not have some knowledge but wish to improve their skills should meet with one of the advisers to discuss appropriate placement.

Preparation.
For the department’s undergraduate adviser, the Education Abroad Program office or the UC Davis Study Abroad Office.

Related Courses.
See East Asian Studies course list.