DEPARTMENT OF GEOLOGY

College of Arts and Sciences
Department of Geology
221 McGilvrey Hall
Kent Campus
330-672-2680
geology@kent.edu
www.kent.edu/geology

Undergraduate Programs
- Earth Science - B.A.
- Geology - B.A.
- Geology - B.S.

Minors
- Geology

Graduate Programs
- Applied Geology - Ph.D.
- Geology - M.S.

Department of Geology Faculty
- Chaudhary, Kuldeep (2017), Assistant Professor, Ph.D., University of Texas-Austin, 2013
- Clement, Susanne M. (1995), Associate Professor, Ph.D., Kent State University, 2005
- Hacker, David B. (1989), Professor, Ph.D., Kent State University, 1998
- Herndon, Elizabeth (2014), Assistant Professor
- Holm, Daniel K. (1992), Professor & Department Chair, Ph.D., Harvard University, 1992
- Jefferson, Anne (2012), Associate Professor, Ph.D., Oregon State University, 2006
- Ortiz, Joseph D. (2001), Professor, Ph.D., Oregon State University, 1995
- Rowan, Christopher (2013), Assistant Professor, Ph.D., University of Southampton, 2006
- Schweitzer, Carrie E. (1994), Professor, Ph.D., Kent State University, 2000
- Singer, David M. (2012), Associate Professor, Ph.D., Stanford University, 2008
- Singh, Kuldeep (2017), Assistant Professor, Ph.D., University of Texas at Austin, 2013
- Smith, Alison J. (1990), Professor & Dean, Ph.D., Brown University, 1991
- Taylor, Eric S. (2012), Associate Professor, Ph.D., The Ohio State University, 2012
- Wells, Neil A. (1984), Professor, Ph.D., University of Michigan, Ann Arbor, 1984
- Williams, Jeremy C. (2015), Assistant Professor, Ph.D., University of Massachusetts, Boston, 2014

Geology (GEOL)

GEOL 11040 HOW THE EARTH WORKS (KBS) 3 Credit Hours
Explores processes that shape Earth’s landscapes (e.g., volcanism, flooding, landslides, sea-level rise, mountain building) and that are of vital interest to humans (e.g., earthquakes, groundwater, energy and mineral resources, climate change).
Prerequisite: None.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter
Attributes: Kent Core Basic Sciences, TAG Science, Transfer Module Natural Sciences

GEOL 11041 HOW THE EARTH WORKS LABORATORY (KBS) (KLAB)
1 Credit Hour
Students study earth materials (e.g., mineral crystals, common and unusual rock specimens) and Google Earth images. Students conduct experiments demonstrating processes at earth’s surface such as groundwater pollution, flooding and earthquakes.
Pre/corequisite: GEOL 11040.
Schedule Type: Laboratory
Contact Hours: 3 lab
Grade Mode: Standard Letter
Attributes: Kent Core Basic Sciences, Kent Core Basic Sciences Lab, TAG Science, Transfer Module Natural Sciences

GEOL 11042 EARTH AND LIFE THROUGH TIME (KBS) 3 Credit Hours
Explores major events in the history of Earth, including mass extinctions, Snowball Earth hypothesis, birth and death of oceans, growth of continents, explosion of life, dinosaurs and the inter-relatedness of earth and life processes.
Prerequisite: None.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter
Attributes: Kent Core Basic Sciences, TAG Science, Transfer Module Natural Sciences

GEOL 11043 EARTH AND LIFE THROUGH TIME LABORATORY (KBS)
(KLAB) 1 Credit Hour
Student conduct lab experiments with fossils, rocks and sedimentary features, a river process simulator and the concept of deep time.
Pre/corequisite: GEOL 11042.
Schedule Type: Laboratory
Contact Hours: 3 lab
Grade Mode: Standard Letter
Attributes: Kent Core Basic Sciences, TAG Science, Transfer Module Natural Sciences

GEOL 11044 EARTH AND LIFE THROUGH TIME LABORATORY (KBS)
(KLAB) 1 Credit Hour
Student conduct lab experiments with fossils, rocks and sedimentary features, a river process simulator and the concept of deep time.
Pre/corequisite: GEOL 11042.
Schedule Type: Laboratory
Contact Hours: 3 lab
Grade Mode: Standard Letter
Attributes: Kent Core Basic Sciences, TAG Science, Transfer Module Natural Sciences

GEOL 21062 ENVIRONMENTAL EARTH SCIENCE (KBS) 3 Credit Hours
Application of Earth science to environmental problems, including natural resource extraction, water supply, pollution, waste disposal, landslides, floods and land use planning. Students take local field trips.
Prerequisite: None.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter
Attributes: Kent Core Basic Sciences, Transfer Module Natural Sciences
GEOL 21080  ALL ABOUT THE OCEANS (KBS)  3 Credit Hours
Explores the many fascinating (and some still little known) features and processes of the Earth's oceans, including mid-ocean ridges, hydrothermal vents, tsunamis, tides, rogue waves, marine life and the role of the ocean in climate change.
Prerequisite: None.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter
Attributes: Kent Core Basic Sciences, Transfer Module Natural Sciences

GEOL 22000  DEGREE AND CAREER PATHS IN GEOLOGY (ELR)  1 Credit Hour
Provides students with an overview of career paths and opportunities in the Geology and Earth Science majors. Components of the course include a journal club; informational presentations by geoscientists in industry, government and academia; and skills training needed for the majors. Required overnight field trip.
Prerequisite: None.
Schedule Type: Lecture
Contact Hours: 1 lecture
Grade Mode: Standard Letter
Attributes: Experiential Learning Requirement

GEOL 23063  EARTH MATERIALS I  4 Credit Hours
Occurrence, associations, characteristics, crystallography and crystal chemistry of common minerals. Laboratory identification emphasizing physical properties. Required field trip.
Prerequisite: GEOL 11040 and GEOL 11041.
Pre/corequisite: CHEM 10060.
Schedule Type: Combined Lecture and Lab
Contact Hours: 5 other
Grade Mode: Standard Letter
Attributes: TAG Science

GEOL 31070  EARTH MATERIALS II (WIC)  4 Credit Hours
Occurrence and origin of igneous, sedimentary and metamorphic rocks. Laboratory identification, description and classification of hand specimens. Required field trip.
Prerequisite: GEOL 23063.
Schedule Type: Laboratory, Lecture
Contact Hours: 3 lecture, 2 lab
Grade Mode: Standard Letter
Attributes: Writing Intensive Course

GEOL 31080  STRUCTURAL GEOLOGY  4 Credit Hours
Mechanical principles of rock deformation. Structures in sedimentary igneous and metamorphic rocks. Lecture three hours lab two hours weekly. Required field trip.
Prerequisite: None.
Schedule Type: Combined Lecture and Lab
Contact Hours: 5 other
Grade Mode: Standard Letter

GEOL 32066  GEOMORPHOLOGY  4 Credit Hours
Earth's surface features as functions of geological structures, processes and time. Landform analysis using topographic maps and some stereographic aerial photos. Trigonometry recommended.
Prerequisite: GEOL 11040 and GEOL 11041.
Schedule Type: Combined Lecture and Lab
Contact Hours: 4 other
Grade Mode: Standard Letter

GEOL 33025  WATER AND THE ENVIRONMENT  3 Credit Hours
How water moves on the surface and in the subsurface, with an emphasis on societal issues such as pollution, the conservation and management of water resources, and the impacts of environmental change.
Prerequisite: None.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 34061  INVERTEBRATE PALEONTOLOGY  4 Credit Hours
Prerequisite: GEOL 11042 and GEOL 11043.
Corequisite: BSCI 10002 or BSCI 10110.
Schedule Type: Combined Lecture and Lab
Contact Hours: 5 other
Grade Mode: Standard Letter

GEOL 41025  GENERAL GEOPHYSICS  3 Credit Hours
(Repeatable for credit)(Slashed with GEOL 51025) Physics of Earth, seismology, geomagnetism, heat flow, radioactivity, geochronology, geotectonic models. Required field trip.
Prerequisite: GEOL 31070 and GEOL 31080 and MATH 12002; and PHY 13001 or PHY 23101.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter-IP

GEOL 40093  VARIABLE TITLE WORKSHOP IN GEOLOGY  1-8 Credit Hours
(Repeatable for credit) Directed field, laboratory and/or library research. (Slashed with GEOL 50093 and GEOL 70093) Workshop and/or training program focused on a specific professional or disciplinary topic.
Prerequisite: Special approval.
Schedule Type: Workshop
Contact Hours: 1-8 other
Grade Mode: Satisfactory/Unsatisfactory

GEOL 40095  SELECTED TOPICS IN GEOLOGY  1-3 Credit Hours
(Repeatable for credit) Selected topics presented by visiting professors or one-time offerings presented by regular faculty.
Prerequisite: 20 credit hours of GEOL courses.
Schedule Type: Lecture
Contact Hours: 1-3 lecture
Grade Mode: Standard Letter

GEOL 40096  INDIVIDUAL INVESTIGATION IN GEOLOGY  1-3 Credit Hours
(Repeatable for credit) Directed field, laboratory and/or library research. Written report required. Maximum 3 credit hours applied toward bachelor’s degree.
Prerequisite: Special approval.
Schedule Type: Individual Investigation
Contact Hours: 1-3 other
Grade Mode: Standard Letter-IP

GEOL 41025  GENERAL GEOPHYSICS  3 Credit Hours
(Repeatable for credit)(Slashed with GEOL 51025) Physics of Earth, seismology, geomagnetism, heat flow, radioactivity, geochronology, geotectonic models. Required field trip.
Prerequisite: GEOL 31070 and GEOL 31080 and MATH 12002; and PHY 13001 or PHY 23101.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter-IP
GEOL 41073 GEOLOGY OF OHIO 3 Credit Hours
(Slashed with GEOL 51073) Minerals, rocks, fossils, structural geology, physiography, environmental geology and geologic resources. Required field trips. Does not count toward the Geology major.
Prerequisite: Junior standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 41077 GEOLOGY OF THE NATIONAL PARKS 3 Credit Hours
(Slashed with GEOL 51077) Introduction to the geology of selected major national parks, emphasizing basic geological principles and the processes that have produced the spectacular scenery, rocks and fossils in each park. Does not count toward the Geology major.
Prerequisite: Junior standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 41079 ALL ABOUT DINOSAURS 3 Credit Hours
(Slashed with GEOL 51079) Dinosaurs (and some relatives) and their world, emphasizing how to interpret evidence concerning their history, biology and evolutionary relationships. Does not count toward the Geology major.
Prerequisite: None.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 41080 TECTONICS AND OROGENY 3 Credit Hours
(Slashed with GEOL 51080) Introduces advanced concepts of plate tectonics and mountain building, with emphasis on Western United States and the Appalachians. Required field trip to New England.
Prerequisite: GEOL 31080.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 41082 ADVANCED STRUCTURAL GEOLOGY 3 Credit Hours
(Slashed with GEOL 51082) Theoretical and applied studies in structural geology, including mechanical, mathematical, model and field investigations. Required field trip.
Prerequisite: GEOL 31080.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 41092 SUMMER FIELD CAMP (ELR) 6 Credit Hours
(Repeatable for credit)(Slashed with GEOL 51092) Five weeks devoted to geologic mapping and solving structural and stratigraphic problems in the Black Hills of South Dakota.
Prerequisite: GEOL 31070 and GEOL 31080.
Schedule Type: Practicum or Internship
Contact Hours: 42 other
Grade Mode: Standard Letter
Attributes: Experiential Learning Requirement

GEOL 42030 REMOTE SENSING 3 Credit Hours
(Cross-listed with GEOG 49230)(Slashed with GEOL 52030, GEOL 72030, GEOG 59230, GEOG 79230) Computer analysis of multispectral satellite datasets. Applications in terrestrial Earth science are emphasized.
Prerequisite: None.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 42035 SCIENTIFIC METHODS IN GEOLOGY 3 Credit Hours
(Slashed with GEOL 52035) Applying scientific methods to geologic data in the field and laboratory; models and sampling procedures. Collecting and analyzing data. Formulating and testing hypotheses. Provides background necessary for upper-division geology courses.
Prerequisite: None.
Schedule Type: Combined Lecture and Lab
Contact Hours: 2 lecture, 2 lab
Grade Mode: Standard Letter

GEOL 42065 WATERSHED HYDROLOGY 3 Credit Hours
(Slashed with GEOL 52065) Study of water movement, storage and transformation across landscapes.
Prerequisite: Junior standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter
GEOL 42069 HYDROGEOCHEMISTRY 3 Credit Hours
(Slashed with GEOL 52069 and GEOL 72069) Processes and evolution of the chemical composition of water in the natural hydrologic cycle. Methods of hydrochemical interpretation applied to ground water and pollution problems.
Prerequisite: 10 credit hours of CHEM courses.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 42074 ENVIRONMENTAL CORE AND WELL LOGGING 3 Credit Hours
(Slashed with GEOL 52074) Examination of subsurface processes and the distribution of stratigraphic layers using core and well-logging techniques and based on analysis of physical properties of sediment, rock and pore fluids. Applications to paleoclimate, hydrogeology, engineering geology, oil and gas exploration and environmental remediation.
Prerequisite: GEOL 31070.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 42078 ENGINEERING GEOLOGY 4 Credit Hours
(Slashed with GEOL 52078) Engineering properties of soils and rocks. Site evaluation for building foundations, dams, tunnels and highways. Slope stability.
Prerequisite: Geology or Earth Science major; and junior standing.
Schedule Type: Combined Lecture and Lab
Contact Hours: 4 other
Grade Mode: Standard Letter

GEOL 43040 PRINCIPLES OF GEOCHEMISTRY 3 Credit Hours
(Slashed with GEOL 53040) Introduction to chemical thermodynamics and its applications in solving geochemical problems. Distributions of elements and isotopes in the Earth and laws governing these distributions.
Prerequisite: CHEM 10060 and CHEM 10061 and GEOL 31070 and MATH 12002.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 43042 ENVIRONMENTAL GEOCHEMISTRY 3 Credit Hours
(Slashed with GEOL 53042 and GEOL 73042) Explores chemical processes that influence the natural environment, including anthropogenic impacts. Topics include atmospheric chemistry and air pollution, energy and climate change, toxic organic compounds, water chemistry and water pollution, metals, soils, sediments and waste disposal. Environmental problem-solving using steady state and non-steady state box models, thermodynamics and energy transfer and chemical reactions and equilibria. Required half-day field trip.
Prerequisite: CHEM 10060 and CHEM 10061.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 43043 ENVIRONMENTAL MINERALOGY 3 Credit Hours
(Slashed with GEOL 53043) Explores reactions between minerals and aqueous solutions, focusing on their role in chemical weathering, contaminant mobility, microbe-mineral interactions and an understanding of mineral-water interface processes and mechanisms at the molecular level. Through a series of case studies, the course explores the societal impacts of environmental contaminants and the potential role of remediation.
Prerequisite: GEOL 23063; and junior standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 43044 ENVIRONMENTAL ISOTOPES 3 Credit Hours
(Slashed with GEOL 53044 and GEOL 73044) Deals with the fundamentals of isotope geochemistry and the application of primarily light stable isotopes (H, O, C, N) to Earth system processes (involving the hydrosphere, biosphere and upper geosphere).
Prerequisite: CHEM 10060 and CHEM 10061.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 44025 GEOLOGIC HAZARDS AND DISASTERS 3 Credit Hours
(Slashed with GEOL 44025) Explores the geological processes that drive a broad range of different natural hazards (including earthquakes, volcanoes, landslides and floods), and how they interact with human behavior to produce geological risks and disasters. Through discussion of historical and topical events, students focus on the dual challenges of combining uncertain and incomplete information from various geological and historical sources into realistic assessments of future risks; and the communication of accurate, relevant, actionable information about these risks to the public and authorities.
Prerequisite: Junior standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 44052 GLACIERS AND GLACIATION 3 Credit Hours
(Cross-listed with GEOG 41052)(Slashed with GEOL 54052, GEOL 74052, GEOG 51052, GEOG 71052) Examination of how glacial ice masses change the shape of the earth's surface, how they are integral to climate and sea level change, and how they pose high risk hazards.
Prerequisite: GEOG 21062 or GEOG 11040.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 44070 SEDIMENTOLOGY AND STRATIGRAPHY 4 Credit Hours
(Slashed with GEOL 54070) Students are introduced to the principles regarding the systematics of sedimentary rocks and the relationships between geologic formations at various spatial and temporal scales. Lectures are integrated with readings from the open literature and required labs and field trips.
Prerequisite: GEOL 31070.
Schedule Type: Combined Lecture and Lab
Contact Hours: 3 lecture, 2 lab
Grade Mode: Standard Letter
<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Credit Hours</th>
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<tbody>
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<td>GEOL 44074</td>
<td>PALEOCEANOGRAPHY</td>
<td>3</td>
<td>A broad spectrum of geological approaches. Paleontology, geochemistry and stratigraphy are employed to interpret the history of earth's oceans.</td>
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<tr>
<td>GEOL 57066</td>
<td>PHYSICAL HYDROGEOLOGY LAB</td>
<td>1</td>
<td>Laboratory course offering fundamental training for professional hydrogeologists.</td>
<td>Graduate standing.</td>
</tr>
<tr>
<td>GEOL 57077</td>
<td>GEOLOGY OF THE BLACK HILLS</td>
<td>3</td>
<td>Theoretical and applied studies in structural geology, including mechanical, mathematical, model and field investigations.</td>
<td>Graduate standing; and special approval.</td>
</tr>
<tr>
<td>GEOL 57080</td>
<td>TECTONICS AND OROGENY</td>
<td>3</td>
<td>Introduces advanced concepts of plate tectonics and mountain building, with emphasis on Western United States and the Appalachians.</td>
<td>Graduate standing.</td>
</tr>
<tr>
<td>GEOL 57092</td>
<td>SUMMER FIELD CAMP</td>
<td>6</td>
<td>Five weeks devoted to geologic mapping and solving structural and stratigraphic problems in the Black Hills of South Dakota.</td>
<td>Graduate standing.</td>
</tr>
<tr>
<td>GEOL 58035</td>
<td>SCIENTIFIC METHODS IN GEOLOGY</td>
<td>3</td>
<td>Applying scientific methods to geologic data in the field and laboratory; models and sampling procedures.</td>
<td>Graduate standing.</td>
</tr>
<tr>
<td>GEOL 58065</td>
<td>WATERSHED HYDROGEOLOGY LAB</td>
<td>1</td>
<td>Laboratory course offering fundamental training for professional hydrogeologists.</td>
<td>Graduate standing.</td>
</tr>
<tr>
<td>GEOL 58066</td>
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<td>GEOL 58077</td>
<td>GEOLOGY OF THE BLACK HILLS</td>
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<td>Theoretical and applied studies in structural geology, including mechanical, mathematical, model and field investigations.</td>
<td>Graduate standing; and special approval.</td>
</tr>
<tr>
<td>GEOL 58080</td>
<td>TECTONICS AND OROGENY</td>
<td>3</td>
<td>Introduces advanced concepts of plate tectonics and mountain building, with emphasis on Western United States and the Appalachians.</td>
<td>Graduate standing.</td>
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<td>Five weeks devoted to geologic mapping and solving structural and stratigraphic problems in the Black Hills of South Dakota.</td>
<td>Graduate standing.</td>
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</table>

Department of Geology
GEOL 52066 PHYSICAL HYDROGEOLOGY 3 Credit Hours
(Slashed with GEOL 42066) Principles of water flow in hydrologic cycle, soil and aquifer hydraulic properties, groundwater flow, surface water–groundwater interactions and geochemical evolution of groundwater. Application of principles for evaluation of water resources; emphasizing utilization, conservation and management of groundwater resources in a changing environment.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 52067 INTRODUCTORY HYDROGEOLOGY 3 Credit Hours
(Slashed with GEOL 42067) Occurrence of ground water in geologic materials; emphasizing utilization, conservation and management of ground water resources.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 52068 CONTAMINANT HYDROGEOLOGY AND HYDROGEOLOGY 3 Credit Hours
(Cross-listed with GEOL 42068) An introduction to the basic principles of chemical and physical behavior of contaminants introduced by humans into the environment. Students are expected to understand concepts and work practical quantitative problems.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 52069 HYDROGEOCHEMISTRY 3 Credit Hours
(Slashed with GEOL 42069 and GEOL 72069) Processes and evolution of the chemical composition of water in the natural hydrologic cycle. Methods of hydrochemical interpretation applied to ground water and pollution problems.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 52074 ENVIRONMENTAL CORE AND WELL LOGGING 3 Credit Hours
(Slashed with GEOL 42074) Examination of subsurface processes and the distribution of stratigraphic layers using core and well-logging techniques and based on analysis of physical properties of sediment, rock and pore fluids. Applications to paleoclimate, hydrogeology, engineering geology, oil and gas exploration and environmental remediation.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 52078 ENGINEERING GEOLOGY 4 Credit Hours
(Slashed with GEOL 42078) Engineering properties of soils and rocks. Site evaluation for building foundations, dams, tunnels and highways. Slope stability.
Prerequisite: Graduate standing.
Schedule Type: Combined Lecture and Lab
Contact Hours: 4 other
Grade Mode: Standard Letter

GEOL 53040 PRINCIPLES OF GEOCHEMISTRY 3 Credit Hours
(Slashed with GEOL 43040) Introduction to chemical thermodynamics and its applications in solving geochemical problems. Distributions of elements and isotopes in the Earth and laws governing these distributions.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 53042 ENVIRONMENTAL GEOCHEMISTRY 3 Credit Hours
(Slashed with GEOL 43042 and GEOL 73042) Explores chemical processes that influence the natural environment, including anthropogenic impacts. Topics include atmospheric chemistry and air pollution, energy and climate change, toxic organic compounds, water chemistry and water pollution, metals, soils, sediments and waste disposal. Environmental problem-solving using steady state and non-steady state box models, thermodynamics and energy transfer and chemical reactions and equilibria. Required half-day field trip.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 53043 ENVIRONMENTAL MINERALOGY 3 Credit Hours
(Slashed with GEOL 43043) Explores reactions between minerals and aqueous solutions, focusing on their role in chemical weathering, contaminant mobility, microbe-mineral interactions and an understanding of mineral-water interface processes and mechanisms at the molecular level. Through a series of case studies, the course explores the societal impacts of environmental contaminants and the potential role of remediation.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 53044 ENVIRONMENTAL ISOTOPES 3 Credit Hours
(Slashed with GEOL 43044 and GEOL 73044) Deals with the fundamentals of isotope geochemistry and the application of primarily light stable isotopes (H, O, C, N) to Earth system processes (involving the hydrosphere, biosphere and upper geosphere).
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 54025 GEOLOGIC HAZARDS AND DISASTERS 3 Credit Hours
(Slashed with GEOL 44025) Explores the geological processes that drive a broad range of different natural hazards (including earthquakes, volcanoes, landslides and floods), and how they interact with human behavior to produce geological risks and disasters. Through discussion of historical and topical events, students focus on the dual challenges of combining uncertain and incomplete information from various geological and historical sources into realistic assessments of future risks; and the communication of accurate, relevant, actionable information about these risks to the public and authorities.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter
GEOL 54052  GLACIERS AND GLACIATION  3 Credit Hours  
(Cross-listed with GEOG 51052)(Slashed with GEOL 44052, GEOL 74052, GEOG 41052, GEOG 71052) Examination of how glacial ice masses change the shape of the earth's surface, how they are integral to climate and sea level change and how they pose high risk hazards.  
Prerequisite: Graduate standing.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

GEOL 54070  SEDIMENTOLOGY AND STRATIGRAPHY  4 Credit Hours  
(Cross-listed with GEOL 44070) Students are introduced to the principles regarding the systematics of sedimentary rocks and the relationships between geologic formations at various spatial and temporal scales. Lectures are integrated with readings from the open literature and required labs and field trips.  
Prerequisite: Graduate standing.  
Schedule Type: Combined Lecture and Lab  
Contact Hours: 3 lecture, 2 lab, 1 other  
Grade Mode: Standard Letter  

GEOL 54074  PALEOCEANOGRAPHY  3 Credit Hours  
(Slashed with GEOL 44074) A broad spectrum of geological approaches. Paleontology, geochemistry and stratigraphy are employed to interpret the history of earth's oceans.  
Prerequisite: Graduate standing.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

GEOL 60080  RESEARCH ORIENTATION  1 Credit Hour  
(Slashed with GEOL 70080) Faculty research presentations; thesis/ dissertation proposal preparation; discussion of professional organizations, preparation of manuscripts and oral presentation of papers.  
Prerequisite: Graduate standing.  
Schedule Type: Lecture  
Contact Hours: 1 lecture  
Grade Mode: Satisfactory/Unsatisfactory  

GEOL 60084  GEOLOGY GRADUATE STUDENT ORIENTATION  1 Credit Hour  
(Slashed with GEOL 70084) Introduction to departmental resources, procedures and expectations, as well as approaches to successfully conduct research at a graduate level. Training and experience in presentation of data and college teaching of applied geology, as well as a discussion forum on professional ethics and responsibilities.  
Prerequisite: Graduate standing.  
Schedule Type: Lecture  
Contact Hours: 1 lecture  
Grade Mode: Satisfactory/Unsatisfactory  

GEOL 60093  WORKSHOP IN COLLEGE TEACHING  1-2 Credit Hours  
(Repeatable for credit)(Slashed with GEOL 71093) Workshop in college teaching.  
Prerequisite: Graduate standing.  
Schedule Type: Workshop  
Contact Hours: 1-2 other  
Grade Mode: Satisfactory/Unsatisfactory  

GEOL 60095  SELECTED TOPICS IN GEOLOGY  1-3 Credit Hours  
(Repeatable for credit)Selected topics presented by visiting professors or one-time offerings presented by regular faculty.  
Prerequisite: Graduate standing.  
Schedule Type: Lecture  
Contact Hours: 1-3 lecture  
Grade Mode: Standard Letter  

GEOL 60098  RESEARCH  1-15 Credit Hours  
(Repeatable for credit)Research for master's level students. Credits earned may be applied toward degree if department approves.  
Prerequisite: Graduate standing.  
Schedule Type: Research  
Contact Hours: 1-15 other  
Grade Mode: Satisfactory/Unsatisfactory-IP  

GEOL 60199  THESIS I  2-6 Credit Hours  
Thesis students must register for a total of 6 hours, 2 to 6 hours in a single semester distributed over several semesters if desired.  
Prerequisite: GEOL 60199; and graduate standing.  
Schedule Type: Masters Thesis  
Contact Hours: 2-6 other  
Grade Mode: Satisfactory/Unsatisfactory-IP  

GEOL 60299  THESIS II  2 Credit Hours  
Thesis students must continue registration each semester until all degree requirements are met.  
Prerequisite: GEOL 60199; and graduate standing.  
Schedule Type: Masters Thesis  
Contact Hours: 2 other  
Grade Mode: Satisfactory/Unsatisfactory-IP  

GEOL 60201  HYDROLOGY  3 Credit Hours  
(Slashed with GEOL 72011) Introduction to hydrologic measurements, properties of water precipitation, evapotranspiration runoff computations, streamflow and flood routing.  
Prerequisite: Graduate standing.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

GEOL 60208  ADVANCED HYDROGEOLOGY  3 Credit Hours  
(Slashed with GEOL 72068) Quantitative approach to occurrence of ground water; methods of investigation, evaluation and development of ground water resources emphasizing optimization and maximal exploitation without environmental changes.  
Prerequisite: Graduate standing.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Details</th>
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</thead>
<tbody>
<tr>
<td>GEOL 62079</td>
<td>ADVANCED ENGINEERING GEOLOGY</td>
<td>3</td>
<td>(Slashed with GEOL 72079) Role of geology in site selection, design and construction relative to dams, tunnels, highways, slope stability and nuclear power plants. Selected case histories. Field trip and term paper required.</td>
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<td>Prerequisite: GEOL 52078; and graduate standing.</td>
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<td>Schedule Type: Lecture</td>
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<tr>
<td>GEOL 62082</td>
<td>INTRODUCTION TO SOIL MECHANICS</td>
<td>4</td>
<td>(Slashed with GEOL 72082) Engineering properties and engineering behavior of soils, including classification properties, compaction permeability strength and compressibility.</td>
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<td>Prerequisite: Graduate standing.</td>
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<td>Schedule Type: Combined Lecture and Lab</td>
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<td>Contact Hours: 5 other</td>
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<tr>
<td>GEOL 62083</td>
<td>ROCK SLOPE STABILITY</td>
<td>3</td>
<td>(Slashed with GEOL 72083) Provide information used to recognize, avoid, design for, control and correct slope movements in rocks; determination of shear strength along rock discontinuities; stability analysis of rock slopes.</td>
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<td>Prerequisite: GEOL 52078 or GEOL 72082; and graduate standing.</td>
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<tr>
<td>GEOL 63063</td>
<td>SEDIMENTARY PETROLOGY</td>
<td>3</td>
<td>(Slashed with GEOL 73063) Classification, texture, composition, provenance and diagenesis of sandstones and carbonates, following review of optical mineralogy. Petrographic microscopy and other laboratory techniques are emphasized.</td>
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<tr>
<td>GEOL 64028</td>
<td>PALEOECOLOGY</td>
<td>3</td>
<td>(Slashed with GEOL 74028) Relationships between ancient organisms and their environments, as interpreted from fossils, enclosing rock strata and recent analogs. Field and laboratory studies. Saturday field trips.</td>
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<tr>
<td>GEOL 64030</td>
<td>SYSTEMATIC INVERTEBRATE PALEONTOLOGY I</td>
<td>3</td>
<td>(Slashed with GEOL 74030) Detailed investigation and examination of important literature concerning taxonomic characters of invertebrate phyla: Protista, Porifera, Cnidaria and Bryozoa. Numerous oral reports, specimen examination.</td>
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<tr>
<td>GEOL 64032</td>
<td>SYSTEMATIC INVERTEBRATE PALEONTOLOGY II</td>
<td>3</td>
<td>(Slashed with GEOL 74032) Detailed investigation and examination of important literature concerning taxonomic characters of invertebrate phyla: Brachiopoda, Mollusca, Arthropoda and Echinodermata. Numerous oral reports, specimen examination.</td>
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<tr>
<td>GEOL 64036</td>
<td>CENOZOIC CLIMATE CHANGE</td>
<td>3</td>
<td>(Slashed with GEOL 74036) An overview of the concepts and principles involved in interpreting global and hemispheric Cenozoic climate change (past 65 million years). Emphasis on particular temporal and spatial scales and cycles. Extensive reading in scientific journals.</td>
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<tr>
<td>GEOL 64038</td>
<td>PALEOLIMNOLOGY</td>
<td>3</td>
<td>(Slashed with GEOL 74038) An overview of significant topics and applications in paleolimnology of Holocene (last 10,000 years) and Pleistocene (last two million years) records, including current issues in environmental and climatic reconstruction. Extensive reading expected.</td>
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<tr>
<td>GEOL 70080</td>
<td>RESEARCH ORIENTATION</td>
<td>1</td>
<td>(Slashed with GEOL 60080) Faculty research presentations; thesis/dissertation proposal preparation; discussion of professional organizations, preparation of manuscripts and oral presentation of papers.</td>
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<td>GEOL 70084</td>
<td>GEOLOGY GRADUATE STUDENT ORIENTATION</td>
<td>1</td>
<td>(Slashed with GEOL 60084) Introduction to departmental resources, procedures and expectations, as well as approaches to successfully conduct research at a graduate level. Training and experience in presentation of data and college teaching of applied geology, as well as discussion forum on professional ethics and responsibilities.</td>
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GEOL 70091 SEMINAR 1-2 Credit Hours
(Repeatable for credit)(Slashed with GEOL 60091) Topics in geology varies per course offering.
Prerequisite: Doctoral standing.
Schedule Type: Seminar
Contact Hours: 1-2 other
Grade Mode: Standard Letter

GEOL 70093 VARIABLE TITLE WORKSHOP IN GEOLOGY 1-8 Credit Hours
(Repeatable for credit)(Slashed with GEOL 40093 and GEOL 50093) Workshop and/or training program, of varying duration focused on a specific professional or disciplinary topic.
Prerequisite: Doctoral standing; and special approval.
Schedule Type: Workshop
Contact Hours: 1-8 other
Grade Mode: Satisfactory/Unsatisfactory

GEOL 71093 WORKSHOP IN COLLEGE TEACHING 1-2 Credit Hours
(Repeatable for credit)(Slashed with GEOL 61093) Workshop in college teaching.
Prerequisite: Doctoral standing.
Schedule Type: Workshop
Contact Hours: 1-2 other
Grade Mode: Satisfactory/Unsatisfactory

GEOL 72011 HYDROLOGY 3 Credit Hours
(Slashed with GEOL 62011) Introduction to hydrologic measurements, properties of water precipitation, evapotranspiration, runoff computations, streamflow and flood routing.
Prerequisite: Doctoral standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 72030 REMOTE SENSING 3 Credit Hours
(Cross-listed with GEOG 71052)(Slashed with GEOL 42030, GEOL 52030, GEOG 41052, GEOG 51052) Computer analysis of multispectral satellite datasets. Applications in terrestrial Earth science are emphasized.
Prerequisite: Doctoral standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 72068 ADVANCED HYDROGEOLOGY 3 Credit Hours
(Slashed with GEOL 62068) Quantitative approach to occurrence of ground water; methods of investigation evaluation and development of ground water resources emphasizing optimization and maximal exploitation without environmental changes.
Prerequisite: Doctoral standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 72069 HYDROGEOCHEMISTRY 3 Credit Hours
(Slashed with GEOL 42069 and GEOL 52069) Processes and evolution of the chemical composition of water in the natural hydrologic cycle. Methods of hydrochemical interpretation applied to ground water and pollution problems.
Prerequisite: Doctoral standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 72079 ADVANCED ENGINEERING GEOLOGY 3 Credit Hours
(Slashed with GEOL 62079) Role of geology in site selection, design and construction relative to dams, tunnels, highways, slope stability and nuclear power plants. Selected case histories. Field trip and term paper required.
Prerequisite: GEOL 52078; and doctoral standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 72082 INTRODUCTION TO SOIL MECHANICS 4 Credit Hours
(Slashed with GEOL 62082) Engineering properties and engineering behavior of soils, including classification properties, compaction permeability strength and compressibility.
Prerequisite: Doctoral standing.
Schedule Type: Lecture
Contact Hours: Combined Lecture and Lab
Grade Mode: Standard Letter

GEOL 72083 ROCK SLOPE STABILITY 3 Credit Hours
(Slashed with GEOL 62083) Provide information used to recognize, avoid, design for control and correct slope movements in rocks; determination of shear strength along rock discontinuities; stability analysis of rock slopes.
Prerequisite: Doctoral standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 72084 FOUNDATION ENGINEERING 3 Credit Hours
Prerequisite: GEOL 52078 or GEOL 72082; and doctoral standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 73042 ENVIRONMENTAL GEOCHEMISTRY 3 Credit Hours
(Slashed with GEOL 43042 and GEOL 53042) Explores chemical processes that influence the natural environment, including anthropogenic impacts. Topics include atmospheric chemistry and air pollution, energy and climate change, toxic organic compounds, water chemistry and water pollution, metals, soils, sediments and waste disposal. Environmental problem-solving using steady state and non-steady state box models, thermodynamics and energy transfer and chemical reactions and equilibria. Required half-day field trip.
Prerequisite: Doctoral standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 73044 ENVIRONMENTAL ISOTOPES 3 Credit Hours
(Slashed with GEOL 43044 and GEOL 53044) Deals with the fundamentals of isotope geochemistry and the application of primarily light stable isotopes (H, O, C, N) to Earth system processes (involving the hydrosphere, biosphere and upper geosphere).
Prerequisite: Doctoral standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter
GEOL 73063 SEDIMENTARY PETROLOGY 3 Credit Hours
(Slashed with GEOL 63063) Classification, texture, composition, provenance and diagenesis of sandstones and carbonates, following review of optical mineralogy. Petrographic microscopy and other laboratory techniques are emphasized.

Prerequisite: Doctoral standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 74028 PALEOECOLOGY 3 Credit Hours
(Slashed with GEOL 64028) Relationships between ancient organisms and their environments, as interpreted from fossils, enclosing rock strata and recent analogs. Field and laboratory studies. Saturday field trips.

Prerequisite: Doctoral standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 74030 SYSTEMATIC INVERTEBRATE PALEONTOLOGY I 3 Credit Hours
(Slashed with GEOL 64030) Detailed investigation and examination of important literature concerning taxonomic characters of invertebrate phyla: Protista, Porifera, Cnidaria and Bryozoa. Numerous oral reports, specimen examination.

Prerequisite: Doctoral standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 74032 SYSTEMATIC INVERTEBRATE PALEONTOLOGY II 3 Credit Hours
(Slashed with GEOL 64032) Detailed investigation and examination of important literature concerning taxonomic characters of invertebrate phyla: Brachiopoda, Mollusca, Arthropoda and Echinodermata. Numerous oral reports, specimen examination.

Prerequisite: Doctoral standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 74036 CENOZOIC CLIMATE CHANGE 3 Credit Hours
(Slashed with GEOL 64036) An overview of the concepts and principles involved in interpreting global and hemispheric Cenozoic climate change (past 65 million years). Emphasis on particular temporal and spatial scales and cycles. Extensive reading in scientific journals.

Prerequisite: Doctoral standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 74052 GLACIERS AND GLACIATION 3 Credit Hours
(Cross-listed with GEOG 71052)(Slashed with GEOG 41052, GEOG 51052, GEOL 44052, GEOL 55052) Examination of how glacial ice masses change the shape of the earth’s surface, how they are integral to climate and sea level change and how they pose high risk hazards.

Prerequisite: Doctoral standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 80095 ADVANCED TOPICS IN GEOLOGY 1-3 Credit Hours
(Repeatable for credit) Advanced topics presented by visiting professors or one-time offerings presented by regular faculty.

Prerequisite: Doctoral standing; and special approval.
Schedule Type: Lecture
Contact Hours: 1-3 lecture
Grade Mode: Standard Letter

GEOL 80098 RESEARCH 1-15 Credit Hours
(Repeatable for credit) Research for doctoral students. Credits earned may be applied toward degree with departmental approval.

Prerequisite: Doctoral standing.
Schedule Type: Research
Contact Hours: 1-15 other
Grade Mode: Satisfactory/Unsatisfactory-IP

GEOL 80199 DISSERTATION I 15 Credit Hours
(Repeatable for credit) Doctoral dissertation, for which registration in at least two semesters is required first of which will be semester in which dissertation work is begun and continuing until the completion of 30 hours. prerequisite: Admission to candidacy for doctoral degree; and doctoral standing.

Schedule Type: Dissertation
Contact Hours: 15 other
Grade Mode: Satisfactory/Unsatisfactory-IP

GEOL 80299 DISSERTATION II 15 Credit Hours
(Repeatable for credit) Continuing registration required of doctoral students who have completed the initial 30 hours of dissertation, continuing until all degree requirements are met.

Prerequisite: GEOL 80199; and doctoral standing.
Schedule Type: Dissertation
Contact Hours: 15 other
Grade Mode: Satisfactory/Unsatisfactory-IP

Department of Geology