MAJOR

The Geosciences major offers an understanding of the evolution of our planet and its interacting global systems. In this era of global change, geoscience provides the tools that can help us learn to live sustainably with our environment, and appreciate our place within the vastness of Earth history. Forces within the Earth create mountain ranges and ocean basins and drive the movements of continents. Wind, water and ice shape the surface of the Earth, making and changing the landscapes around us. Sedimentary rocks and the fossils within them teach us how life and climate have evolved over the vastness of time.

Geosciences graduates have a wide range of career options, both with and without graduate training. The many choices include environmental consulting, hazard assessment, hydrology, gemology, the energy and mining industries, outdoor education, and research and teaching in universities, colleges, and secondary schools. Many students choose to double-major in fields as diverse as Art, Economics, History, Physics, Mathematics, English, and Philosophy, and often find jobs where they can apply the synergies of their Geosciences double major. No matter what field they enter, all our Geosciences graduates pursue their lives and careers with a deeper appreciation for the natural world around them.

The major is designed to provide a solid grounding in the geosciences while being adaptable enough to accommodate diverse paths driven by student interests. There are no required courses, but students work through the menu below, which allows a lot of scheduling flexibility.

The requirements for the Geosciences major were revised. The new requirements are immediately below, and the old requirements follow. Students who entered Williams in fall 2019 or after are under the new requirements. Students who entered Williams before fall 2019 are under the old requirements but may opt into the new requirements. Please talk to the Geosciences chair if you have questions about the major requirements.

Geosciences major requirements for students who entered Williams in fall 2019 or after:

At least one and at most two 100-level courses:
- GEOS 100 Introduction to Weather and Climate
- GEOS 101 Co-Evolution of Earth and Life
- GEOS 102 An Unfinished Planet
- GEOS 103 Global Warming and Environmental Change
- GEOS 104 Oceanography
- GEOS 107 Astrobiology

At least two 200-level courses selected from this group:
- GEOS 201 Geomorphology
- GEOS 202 Mineralogy
- GEOS 203 Field Methods and Structural Geology
- GEOS 205 Economic Geology and Earth Resources
- GEOS 210 Oceanographic Processes
- GEOS 212 Paleobiology
- GEOS 214 Mastering GIS
At least two 300-level courses selected from this group:

- GEOS 301 Structural Geology
- GEOS 302 Sedimentology
- GEOS 303 Igneous and Metamorphic Petrology
- GEOS 309 Modern Climate
- GEOS 314 Analytical Historical Geology
- GEOS 324 Corals and Sea Level

At least one of the following 400-level courses:

- GEOS 401 Global Tectonics and the Rise of Mountains
- GEOS 404 Coastal Processes and Geomorphology
- GEOS 405 Geochemistry: Understanding Earth’s Environment
- GEOS 410 The Cryosphere
- GEOS 411 Geobiology

Finally, students must take enough electives to bring the total to a minimum of nine courses.

In addition, courses taken for the major must include at least two courses from each of the following three groups:

**Climate and Oceans:**

- GEOS 100 Introduction to Weather and Climate
- GEOS 104 Oceanography
- GEOS 210 Oceanographic Processes
- GEOS 215 Climate Changes
- GEOS 221T Climate Science and Politics
- GEOS 255 Environmental Observation
- GEOS 309 Modern Climate
- GEOS 324 Corals and Sea Level

**Sediments and Life:**

- GEOS 101 Co-Evolution of Earth and Life
- GEOS 103 Global Warming and Environmental Change
- GEOS 107 Astrobiology
- GEOS 201 Geomorphology
- GEOS 212 Paleobiology
- GEOS 302 Sedimentology
- GEOS 312T Mass Extinctions
- GEOS 314 Analytical Historical Geology

**Solid Earth:**

- GEOS 102 Unfinished Planet
- GEOS 202 Mineralogy
- GEOS 203 Field Methods and Structural Geology
- GEOS 205 Economic Geology and Earth Resources
- GEOS 217 Planets and Moons
- GEOS 220T Evolution of and on Volcanic Islands
- GEOS 250T Tectonic Geomorphology and Landscape Evolution
GEOS 301 Structural Geology
GEOS 303 Igneous and Metamorphic Petrology

Geosciences major requirements for students who entered Williams before fall 2019:

At least one and at most two 100-level courses:
GEOS 100 Introduction to Weather and Climate
GEOS 101 The Co-Evolution of Earth and Life
GEOS 102 An Unfinished Planet
GEOS 103 Global Warming and Environmental Change the Reshaping of Landscapes
GEOS 104 Oceanography
GEOS 107 Astrobiology

At least two 200-level courses selected from this group:
GEOS 201 Geomorphology
GEOS 202 Mineralogy
GEOS 203 Field Methods and Structural Geology
GEOS 205 Earth Resources
GEOS 210 Oceanographic Processes
GEOS 212 Paleobiology
GEOS 214 Mastering GIS
GEOS 215 Climate Changes
GEOS 217 Planets and Moons
GEOS 255 Environmental Observation

At least two 300-level courses selected from this group:
GEOS 302 Sedimentology
GEOS 303 Igneous and Metamorphic Petrology
GEOS 309 Modern Climate
GEOS 314 Analytical Historical Geology
GEOS 324 Corals and Sea Level

At least one of the following 400-level courses:
GEOS 401 Global Tectonics and the Rise of Mountains
GEOS 404 Coastal Processes and Geomorphology
GEOS 405 Geochemistry: Understanding Earth’s Environment
GEOS 410 The Cryosphere
GEOS 411 Geobiology

Finally, students must take enough electives to bring the total to a minimum of nine courses.

PREPARATION FOR GRADUATE SCHOOL

Although many of our majors take geoscience jobs after graduation, many choose to go to graduate school, and most graduate programs will expect students to have a background in mathematics as well as a year or so of study in related sciences, in addition to the requirements of the Geosciences major. Students considering graduate work in geosciences should therefore consult with faculty to ensure that they plan wisely. The selection of outside courses will depend on the field in which a student wants to specialize. Graduate programs in solid-earth geosciences commonly expect entering students to have taken courses in chemistry. For those going into environmental geosciences, courses in chemistry, computer science and/or statistics are recommended. For those considering geobiology programs, biology courses are important. For students entering planetary geology, physics is recommended.

THE DEGREE WITH HONORS IN GEOSCIENCES

The degree with honors in Geosciences provides students with an opportunity to undertake an independent research project under the supervision
of a faculty member, culminating in a thesis that demonstrates outstanding achievement of an original and innovative nature. In addition to the major requirements listed above, those who are candidates for the degree with honors take the following sequence in the Fall, Winter Study, and Spring of their senior year:

GEOS 493-031-494 Senior Research and Thesis

The principal considerations in admitting a student to a program of independent research are interest and motivation, mastery of fundamental material and skills, and ability to pursue independent study successfully. Interested students should talk to members of the department about project options at any time, but generally no later than January of the Junior year.

STUDY AWAY

Students planning to study off-campus should meet as early as possible with the Department Chair to plan and to discuss how potential courses might be used in the major. Although most study-away programs do not offer geoscience courses, there are some that dovetail well with Geosciences. Examples include the Williams-Mystic program, the Frontiers Abroad program at Canterbury University in New Zealand, and the program at the University of Otago in New Zealand. Courses offered at Norwegian Technical Universities and at several universities in the United Kingdom have also been accepted. Up to two geoscience courses taken away from Williams can be counted toward the nine-course major. Be sure to meet with a Geosciences faculty advisor or Department Chair to discuss your plans and ideas for off-campus work.

FAQ

Students MUST contact departments/programs BEFORE assuming study away credit will be granted toward the major or concentration.

Can your department or program typically pre-approve courses for major/concentration credit?

Generally not until after a student returns and can provide course material for review (e.g. Syllabus and/or completed work such as exams, portfolios, lab reports and the like).

What criteria will typically be used/required to determine whether a student may receive major/concentration credit for a course taken while on study away?

Complete syllabus and course description, including readings, assignments, evaluation criteria.

Does your department/program place restrictions on the number of major/concentration credits that a student might earn through study away?

Yes. A maximum of two courses can be credited toward major requirements.

Does your department/program place restrictions on the types of courses that can be awarded credit towards your major?

No.

Are there specific major requirements that cannot be fulfilled while on study away?

No.

Are there specific major requirements in your department/program that students should be particularly aware of when weighing study away options? (Some examples might include a required course that is always taught in one semester, laboratory requirements.)

Students should consult with the chair or other department faculty members to plan ahead and make sure that requirements can be met.

Give examples in which students thought or assumed that courses taken away would count toward the major or concentration and then learned they wouldn’t:

None to date.

GEOS 100 (S) Introduction to Weather and Climate

Cross-listings: GEOS 100 ENVI 100
How is it that we have such a hard time predicting if it's going to rain next week, but we can be confident in projections of future climate change decades from now? This course will explore the atmosphere and how air moves and changes, understanding the wind, clouds, precipitation, and extreme events (including thunderstorms, hurricanes, and tornados) that form our weather. Building off of our understanding of the atmosphere, we'll look at longer time scales to develop a basic understanding of earth's climate, global heat and moisture transport, climate change, and the ways that humans can change our planet. We will look at weather and climate models to learn how to scientists and meteorologists predict future conditions.

Labs will include local field trips, bench top experiments, and running a climate model on a computer. This course is in the Oceans and Climate group for the Geosciences major.

Requirements/Evaluation: lab assignments, a midterm, and a final exam

Prerequisites: none

Enrollment Limit: 40

Enrollment Preferences: first year and second year students, Geosciences majors

Expected Class Size: 40

Grading: no pass/fail option, no fifth course option

Distributions: (D3)

This course is cross-listed and the prefixes carry the following divisional credit:

GEOS 100 (D3) ENVI 100 (D3)

Attributes: ENVI Natural World Electives EXPE Experiential Education Courses GEOS Group A Electives - Climate + Oceans

Not offered current academic year

GEOS 101 (F) The Co-Evolution of Earth and Life

Cross-listings: GEOS 101 ENVI 105

Primary Cross-listing

Our planet is about 4.6 billion years old and has supported life for at least the last 3.5 billion of those years. This course will consider the inter-related nature of Earth and the life that inhabits it, starting with the first living organisms and progressing to the interaction of our own species with the Earth today. Students will investigate the dynamic nature of the Earth-life system, examine many of its feedbacks, and learn about the dramatic changes that have occurred throughout the history of the Earth. We will ask questions such as: How did the Earth facilitate biologic evolution, and what effects did those biologic events have on the physical Earth? When did photosynthesis evolve, how can we detect that in the rock record, and how did this biological event lead to profound changes in the environment? How and why did animals evolve and what role did environmental change play in the radiation of animal life? How did the rise and radiation of land plants affect world climate? How do plate tectonics, glaciation, and volcanism influence biodiversity and evolutionary innovation? What caused mass extinctions in the past and what can that teach us about our current extinction crisis?

Labs will involve hands-on analysis of rocks, fossils, and real-world data as well as conceptual and analytical exercises; field trips will contextualize major events in Earth history and will help students learn to read the rock record. Through these investigations, the class will provide a comprehensive overview of Earth history, with special attention paid to the geological and paleontological history of the northeastern United States. This course is in the Sediments and Life group for the Geosciences major.

Class Format: one laboratory per week plus one all-day field trip

Requirements/Evaluation: lab work, short quizzes, midterms, an independent project, and a final exam

Prerequisites: none

Enrollment Limit: 30

Enrollment Preferences: first year and second year students, Geosciences majors

Expected Class Size: 30

Grading: yes pass/fail option, no fifth course option

Distributions: (D3)

This course is cross-listed and the prefixes carry the following divisional credit:

GEOS 101 (D3) ENVI 105 (D3)

Attributes: ENVI Natural World Electives EXPE Experiential Education Courses GEOS Group B Electives - Sediments + Life
GEOS 102  (S)  An Unfinished Planet

The Earth is a work-in-progress, an evolving planet whose vital signs--as expressed by earthquakes, volcanic eruptions, and shifting plates--are still strong. In a geological time frame, nothing on Earth is permanent: ocean basins open and close, mountains rise and fall, continental masses accrete and separate. There is a message here for all of us who live, for an infinitesimally brief time, on the moving surface of the globe. This course uses the plate tectonics model--one of the fundamental scientific accomplishments of the past century--to interpret the processes and products of a changing Earth. The emphasis will be on mountain systems (on land and beneath the oceans) as expressions of plate interactions. Specific topics include the rocks and structures of modern and ancient mountain belts, the patterns of global seismicity and volcanism, the nature of the Earth's interior, the changing configurations of continents and ocean basins through time, and, in some detail, the formation of the Appalachian Mountain system and the geological assembly of New England. Readings will be from a physical geology textbook, a primary source supplement, selected writings of John McPhee, and references about the geology of the Northeast. This course is in the Solid Earth group for the Geosciences major.

Class Format: lecture three hours per week and lab (several involving field work) two hours per week; one required all-day field trip on the last Monday of the semester to the Connecticut Valley and the highlands of western Massachusetts

Requirements/Evaluation: two hour-tests, weekly lab work, and a scheduled final exam

Prerequisites: none

Enrollment Limit: 30

Enrollment Preferences: first year and second year students, Geosciences majors

Expected Class Size: 30

Grading: yes pass/fail option, yes fifth course option

Distributions: (D3)

Attributes: ENVI Natural World Electives  EXPE Experiential Education Courses  GEOS Group C Electives - Solid Earth

GEOS 103  (F)  Global Warming and Environmental Change

Cross-listings: GEOS 103  ENVI 103

Primary Cross-listing

Earth is the warmest it has been for at least five centuries, and the surface of our planet is responding. From extreme floods and drought to landslides and soil erosion, the natural processes that shape Earth's surface are tied to temperature and precipitation. As those change, the landscape reacts. People are beginning to feel the impacts, but in different ways depending on where they call home. In this course, we will investigate how climate change is altering landscapes and the natural processes that support them, highlighting all the ways that people are being affected today. Ultimately, we will develop an understanding of the consequences of climate change that connects physical processes with the geography of place. Specific topics include foundations of the Earth system, plate tectonics and the construction of landscapes, Earth materials, rivers and flooding, hillslope processes, coastal processes, and climate impacts on natural resources such as fresh water and soil. Labs will use local field sites and analytical exercises to evaluate recent cases that reflect an interaction of the landscape and climate. This course is in the Sediments and Life group for the Geosciences major.

Class Format: The course will have a hybrid format, with lectures taking place on-line and labs meeting in-person. Labs will take place every other week for two hours, and we will virtually meet each week for discussion.

Requirements/Evaluation: written reports from laboratories and readings, class participation, a midterm and final exam

Prerequisites: none

Enrollment Limit: 40

Enrollment Preferences: first year and second year students, Geosciences majors and Environmental Studies majors and concentrators

Expected Class Size: 40

Grading: yes pass/fail option, no fifth course option

Distributions: (D3)

This course is cross-listed and the prefixes carry the following divisional credit:

GEOS 103 (D3)  ENVI 103 (D3)
Fall 2020

LAB Section: H2  T 3:30 pm - 5:30 pm  José A. Constantine
LAB Section: H3  R 3:30 pm - 5:30 pm  José A. Constantine
LEC Section: R1  TBA  José A. Constantine

**GEOS 104 (S) Oceanography**

**Cross-listings:** GEOS 104  MAST 104  ENVI 104

**Primary Cross-listing**

The oceans cover three quarters of Earth's surface, yet oceanography as a modern science is relatively young: the first systematic explorations of the geology, biology, physics and chemistry of the oceans began in the late 19th century. This introduction to ocean science includes the creation and destruction of ocean basins with plate tectonics; the source and transport of seafloor sediments and the archive of Earth history they contain; currents, tides, and waves; photosynthesis and the transfer of energy and matter in ocean food webs; the composition and origin of seawater, and how its chemistry traces biological, physical and geological processes; oceans and climate change; and human impacts. This course is in the Oceans and Climates group for the Geosciences major.

**Class Format:** Remote lectures, students attend a 2-hour lab every other week. Lab meetings will be a mixture of remote, and in-person/hybrid formats. If public health conditions allow, there may be a field trip.

**Requirements/Evaluation:** two midterm exams, homework, lab work, and a final exam

**Prerequisites:** none

**Enrollment Limit:** 48

**Enrollment Preferences:** first year and second year students, Geosciences majors, Maritime Studies concentrators

**Expected Class Size:** 48

**Grading:** yes pass/fail option, no fifth course option

**Distributions:** (D3)

**This course is cross-listed and the prefixes carry the following divisional credit:**

GEOS 104 (D3)  MAST 104 (D3)  ENVI 104 (D3)

**Attributes:** ENVI Natural World Electives  EXPE Experiential Education Courses  GEOS Group A Electives - Climate + Oceans

Spring 2021

LAB Section: H2  M 1:00 pm - 3:00 pm  Mea S. Cook
LAB Section: H3  W 1:00 pm - 3:00 pm  Mea S. Cook
LEC Section: R1  MWF 10:40 am - 11:30 am  Mea S. Cook

**GEOS 106 (F) Being Human in STEM (DPE)**

**Cross-listings:** PHYS 106  GEOS 106  STS 106

**Secondary Cross-listing**

This course combines academic inquiry and community engagement to investigate the themes of diversity and social climate within STEM (science, technology, engineering and mathematics) disciplines. Students will examine how diverse identities including but not limited to gender, race, disability, sexuality, national origin, socioeconomic status, religion, and ethnicity shape the STEM experience both at Williams and nationally. We will ground our understanding through critical reading of primary scholarly research on topics such as implicit bias, identity threat, and effects of team diversity on excellence. From there, we will execute small group projects. Students will design, execute, and evaluate interventions that relate to the course goals and that have direct relevance to Williams students, faculty, and staff. For example, a student group could implement a survey of minoritized STEM students, or create a qualitative interview-based assessment of how socioeconomic status impacts students’ abilities to participate in STEM fields. Course work includes weekly readings, reflective/opinion writing, in class discussion, and the development and presentation of a group project.

**Class Format:** class discussions, group project work (out of class time required)
Requirements/Evaluation: short response papers, class discussion participation, leading class discussions, group work, and final project

Enrollment Limit: 15

Enrollment Preferences: DIV III majors; statement of interest may be requested

Expected Class Size: 15

Grading: no pass/fail option, yes fifth course option

Unit Notes: does not count towards GEOS or PHYS major credit

Distributions: (D3) (DPE)

This course is cross-listed and the prefixes carry the following divisional credit:

PHYS 106 (D3) GEOS 106 (D3) STS 106 (D2)

Difference, Power, and Equity Notes: This course explicitly addresses the intersection of marginalized identities and the STEM experience. Students will learn how to critically address how issues such as gender, race, ethnicity, and disability impact participation in and the experience of STEM fields. For example, students will read and critique literature documenting bias in STEM fields, and will also learn about and create interventions that can address these biases.

Not offered current academic year

GEOS 107  (F)  Astrobiology

Cross-listings: GEOS 107 ASTR 107

Primary Cross-listing

Astrobiology is the study of the origin, evolution, and distribution of life in the universe. As such it is an inherently interdisciplinary field, incorporating all of the basic natural sciences: biology, chemistry, physics, astronomy, and the earth sciences, as well as aspects of philosophy, sociology, and engineering. Questions we will seek answers to in this class include: How, why, when, and where did life evolve on Earth, and what does that tell us about how it might evolve elsewhere? What are the chances that there is life on other planets and moons in our solar system, and why? Are there habitable planets elsewhere in the universe, and will we ever truly know if any of them contain life? We will approach these questions using a combination of lectures, activities, labs, homework assignments, and virtual visits from some of the country’s leading Astrobiology researchers. Examples of lab and homework activities include exploring our definition of life by making observations about living and non-living systems, examining evidence for ancient habitable environments in rocks, reconstructing the geological history of Mars using satellite imagery, and modeling exoplanet atmospheres using computer simulations. Assessment will be based on participation, quizzes, labs and homework assignments, and a final group project where students will write a mock NASA mission proposal. This course is in the Sediments and Life group for the Geosciences major.

Class Format: All lecture components will be via asynchronous online content. Labs will have in person and remote options; in person lab group will meet every other week and have virtual group project work on alternate weeks.

Requirements/Evaluation: Assessment will be based on participation, quizzes, labs and homework assignments, and a final group project where students will write a mock NASA mission proposal.

Prerequisites: none

Enrollment Limit: 48

Enrollment Preferences: first year and second year students, Geosciences majors

Expected Class Size: 48

Grading: yes pass/fail option, yes fifth course option

Unit Notes: This course counts towards the GEOS Group B Electives - Sediments and Life

Distributions: (D3)

This course is cross-listed and the prefixes carry the following divisional credit:

GEOS 107 (D3) ASTR 107 (D3)

Attributes: GEOS Group B Electives - Sediments + Life

Fall 2020

LAB Section: H2  T 1:00 pm - 3:00 pm  Phoebe A. Cohen

LAB Section: H3  W 1:00 pm - 3:00 pm  Phoebe A. Cohen
GEOS 202 (F) Mineralogy
This course could be subtitled "An Introduction to Earth Materials and Analytical Techniques." As the basis for all subsequent solid-earth courses in the major, it provides a systematic framework for the study of minerals--Earth's building blocks: their physical and chemical properties at all scales and the common analytical methods used to identify and interpret them. The course progresses from hand-specimen morphology and crystallography through element distribution and crystal chemistry to the phase relations, compositional variation, and mineral associations within major rock-forming mineral systems. Laboratory work includes the determination of crystal symmetry; mineral separation; the principles and applications of optical emission spectroscopy; wavelength- and energy-dispersive x-ray spectrochemical analysis; x-ray diffraction; the use of the petrographic microscope; and the identification of important minerals in hand specimen and thin section. This course is in the Solid Earth group for the Geosciences major.

Class Format: Hybrid. lecture three hours per week and laboratory three hours per week; independent study of minerals in hand specimen; one afternoon field trip

Requirements/Evaluation: one hour test, lab work, and a final exam
Prerequisites: one 100-level GEOS course or permission of instructor
Enrollment Limit: 14
Enrollment Preferences: sophomores and juniors planning to take GEOS 301, 302 and/or 303 in the subsequent year
Expected Class Size: 12
Grading: yes pass/fail option, no fifth course option
Distributions: (D3)
Attributes: EXPE Experiential Education Courses GEOS Group C Electives - Solid Earth MTSC Courses

GEOS 203 (F) Field Methods and Structural Geology (WS)
Geologic history is preserved in rocks and it can be deciphered using fundamental principles such as superposition and cross-cutting relationships. Field observations are essential to understanding the rock record, and data and interpretations are encoded in geologic maps. This course introduces students to topographic and geologic maps, best practices for geologic field work, the field identification of common minerals and rocks, geologic contacts, and structures such as folds, and faults. Students will develop skills for presenting field data in papers, figures, and oral presentations. This course is in the Solid Earth group for the Geosciences major.

Class Format: lecture and discussion, three hours per week and laboratory, three hours per week
Requirements/Evaluation: short weekly writing assignments will form the basis for two 10-page papers based on field trips and a final independent project
Prerequisites: none
Enrollment Limit: 12
Enrollment Preferences: Geosciences majors or students with a strong interest in geosciences
Expected Class Size: 8
Grading: no pass/fail option, no fifth course option
Materials/Lab Fee: $15 for field supplies
Distributions: (D3) (WS)
Writing Skills Notes: There will be two 10-page papers, each based on four field trips. Students will submit short field descriptions and figures with captions after each field trip. The shorter assignments will be incorporated in two papers. Students will receive from the instructor timely comments on their writing skills, with suggestions for improvement.
Attributes: GEOS Group C Electives - Solid Earth

Not offered current academic year
GEOS 205 (F) Economic Geology and Earth Resources

Cross-listings: GEOS 205 ENVI 207

Primary Cross-listing

"If it can't be grown, it must be mined." We depend on the solid Earth for a huge array of resources. The metal in your soda can, the plastic in your Nalgene, the components of your computer, the glass in your window, the hydrocarbons being burned to keep you warm in the winter or to transport you in cars or aircraft, the cars and aircraft themselves: all are made of materials mined from the Earth. Right now there are more people building more houses, paving more roads, making more vehicles, more electronics, and more plastic packaging-all with geologic materials. As demand soars in both established and growing economies, and as we realize the environmental damage that can result from resource extraction and processing, the importance of understanding Earth's resources increases. Finding new deposits and managing those we have requires insight into the geology that underlies the location and origin of strategic Earth materials. This class introduces the geologic processes that control formation, distribution, and extent of materials reserves: dimension stone and gravel, base and precious metal ores, gemstones, petroleum, nuclear energy sources, and specialty materials for medical, technological, and military uses. This course is in the SOLID EARTH GROUP for the Geosciences major.

Class Format: 2.5 hours lecture per week and one 3 hour lab per week, including some field labs

Requirements/Evaluation: one hour exam, a final exam, lab exercises, and a group project

Prerequisites: one 100-level GEOS course or permission of instructor

Enrollment Limit: 18

Enrollment Preferences: sophomores and Geosciences majors

Expected Class Size: 18

Grading: no pass/fail option, no fifth course option

Distributions: (D3)

This course is cross-listed and the prefixes carry the following divisional credit:

GEOS 205 (D3) ENVI 207 (D3)

Attributes: ENVI Natural World Electives GEOS Group C Electives - Solid Earth

Not offered current academic year

GEOS 207 (F)(S) The Geoscience of Epidemiology and Public Health (DPE)

Cross-listings: ENVI 201 GEOS 207

Primary Cross-listing

The Coronavirus pandemic has highlighted the many ways that diseases can be transmitted in the environment. As a society we are becoming aware of the many ways that geological processes and materials and influence human health, in ways both beneficial and dangerous. This course unites geoscience, biomedicine and public health approaches to address a wide range of environmental health problems. These include water-related illnesses (e.g. diarrhea, malaria); minerals and metals, both toxic (e.g. asbestos, arsenic) and essential (e.g. iodine); radioactive poisoning (e.g. radon gas); and the transport of pathogens by water and wind. In many cases, the environmental health problems disproportionately affect marginalised populations, contributing to greater disease and death among poor communities and populations of colour. We will examine the broad array of dynamic connections between human health and the natural world. We will discuss the social justice implications of a range of environmental health problems. And we will examine current research into how coronaviruses, such as the one causing COVID-19, are transported in the environment. This course is in the Sediments and Life group for the Geosciences Major.

Class Format: Hybrid format. Specific organisational details will depend on the number of students enrolled, but will include both synchronous and asynchronous components, with both in-person and remote teaching. Particular care will be taken to make sure that fully remote students can participate fully and experience the same content and discussion richness. To make sure that remote students receive equal attention, some sections will be designated as fully remote and others as in-person.

Requirements/Evaluation: Evaluation will be based on short weekly writing assignments as well as an individual project and poster presentation.

Prerequisites: No prerequisites

Enrollment Limit: 34

Enrollment Preferences: Preference to first-years, sophomores, and prospective Geosciences majors

Expected Class Size: 30

Grading: yes pass/fail option, yes fifth course option
Distributions: (D3) (DPE)

This course is cross-listed and the prefixes carry the following divisional credit:

ENVI 201 (D3) GEOS 207 (D3)

Difference, Power, and Equity Notes: Through a series of case studies, we will examine ways in which marginalised groups (whether due to poverty, race, or ethnicity) are disproportionately affected by environmental health issues. Themes of power and equity in terms of decision making, access to knowledge, and funding availability, will be woven into all aspects of the class and will underpin our analysis of the science.

Attributes: ENVI Natural World Electives GEOS Group B Electives - Sediments + Life PHLH Nutrition, Food Security + Environmental Health

Fall 2020
CON Section: 02    T 1:15 pm - 3:00 pm    Rónadh Cox
LEC Section: H1    TR 11:30 am - 12:45 pm    Rónadh Cox
CON Section: R3    R 1:15 pm - 3:00 pm    Rónadh Cox

Spring 2021
LEC Section: H1    TR 11:30 am - 12:45 pm    Rónadh Cox
LAB Section: H2    T 1:15 pm - 3:15 pm    Rónadh Cox
LAB Section: H3    R 1:15 pm - 3:15 pm    Rónadh Cox

GEOS 210 (S) Oceanographic Processes

Cross-listings: MAST 211 GEOS 210

Secondary Cross-listing
This course examines ocean and coastal environmental science issues including carbon dioxide and the ocean's role in climate, El Niño and other ocean-atmosphere oscillations that influence our weather, coastal erosion and other hazards, coastal pollution, and fisheries. The focus is on controlling processes with regional comparisons. Blue water oceanography is conducted in the Atlantic and comparative coastal oceanography includes trips to southern New England shores, and the West and Gulf coasts of the US as part of the Williams-Mystic program. This course is in the Oceans and Climate group for the Geosciences major.

Class Format: including coastal and near-shore field trips, 11 days offshore, and a laboratory or field research project

Requirements/Evaluation: two tests, a research project, and a presentation

Prerequisites: none

Enrollment Limit: 24

Enrollment Preferences: none

Expected Class Size: 10

Grading: yes pass/fail option, yes fifth course option

Unit Notes: offered only at Mystic Seaport

Distributions: (D3)

This course is cross-listed and the prefixes carry the following divisional credit:

MAST 211 (D3) GEOS 210 (D3)

Attributes: ENVI Natural World Electives EVST Living Systems Courses EXPE Experiential Education Courses GEOS Group A Electives - Climate + Oceans

Not offered current academic year

GEOS 212 (S) Paleobiology

Cross-listings: GEOS 212 BIOL 211

Primary Cross-listing
The fossil record is a direct window into the history of life on Earth and contains a wealth of information on evolution, biodiversity, and climate change. This course investigates the record of ancient life forms, from single-celled algae to snails to dinosaurs. In addition to the intellectual discovery of fossils as organic relics and the ways in which fossils have been used to support conflicting views on nature, geologic time, and evolution, we will
cover a range of topics central to modern paleobiology. These include: how the fossil record informs our understanding of evolutionary processes including speciation; the causes and consequences of mass extinctions; how fossils help us tell time and reconstruct the Earth's climatic and tectonic history; statistical analysis of the fossil record to reconstruct biodiversity through time; analysis of fossil morphology to recreate the biomechanics of extinct organisms; and using fossil communities to reconstruct past ecosystems. Laboratory exercises will take advantage of Williams' fossil collections as well as published datasets to provide a broad understanding of fossils and the methods we use to study the history of life on Earth, including using the programming language R (no previous experience is required). We will also view a diversity of fossils in their geologic and paleo-environmental context on our field trip to Eastern New York. This course is in the Sediments and Life group for the Geosciences major.

Class Format: field trip to the the Paleozoic of New York State

Requirements/Evaluation: lab assignments, short quizzes and writing assignments, and a final exam

Prerequisites: any 100-level GEOS course or BIOL 102, 203 or 205

Enrollment Limit: 15

Enrollment Preferences: sophomore and junior GEOS majors

Expected Class Size: 12

Grading: no pass/fail option, no fifth course option

Unit Notes: does not satisfy the distribution requirement for the Biology major

Distributions: (D3)

This course is cross-listed and the prefixes carry the following divisional credit:

GEOS 212 (D3) BIOL 211 (D3)

Attributes: EXPE Experiential Education Courses GEOS Group B Electives - Sediments + Life MAST Interdepartmental Electives

Not offered current academic year
GEOS 215 (F) Climate Changes

Cross-listings: GEOS 215 ENVI 215

Primary Cross-listing

In recent years, there has been a growing public and scientific interest in the Earth's climate and its variability. This interest reflects both concern over future climate changes resulting from anthropogenic increases in atmospheric greenhouse gases and growing recognition of the economic impact of "natural" climate variability (for example, El Niño events), especially in the developing world. Efforts to understand the Earth's climate system and predict future climate changes require both study of parameters controlling present day climate and detailed studies of climate changes in the past. In this course, we will review the processes that control the Earth's climate, like solar radiation, the greenhouse effect, ocean circulation, configuration of continents, and positive and negative feedbacks. At the same time, we will review the geological record of climate changes in the past, examining their causes. Laboratories and problem sets will emphasize developing problem solving skills as well as sampling and interpreting geological archives of climate change. This course is in the Oceans and Climate group for the Geosciences major.

Class Format: This class has three scheduled remote lectures per week, and one remote lab meeting per week which will consist of lab exercises, problem solving and discussion

Requirements/Evaluation: lab exercises and problem sets (25%), three exams (50%), and a final project (25%) where students will collect, analyze, and interpret data

Prerequisites: 100-level course in GEOS, CHEM, or PHYS or ENVI 102 or permission of instructor

Enrollment Limit: 16

Enrollment Preferences: Geosciences and Environmental Studies majors

Expected Class Size: 16

Grading: yes pass/fail option, yes fifth course option

Distributions: (D3)

This course is cross-listed and the prefixes carry the following divisional credit:

GEOS 215 (D3) ENVI 215 (D3)

Attributes: ENVI Natural World Electives EVST Environmental Science EXPE Experiential Education Courses GEOS Group A Electives - Climate + Oceans MAST Interdepartmental Electives

Fall 2020

LEC Section: R1 MWF 10:40 am - 11:30 am Mea S. Cook
LAB Section: R2 T 1:00 pm - 3:00 pm Mea S. Cook

GEOS 217 (S) Planets and Moons

Cross-listings: ASTR 217 GEOS 217

Primary Cross-listing

This course examines the history and geology of the solar system. No two planets are exactly alike, and as we acquire more data and higher-resolution images, our sense of wonder grows. However, we can't hike around and hammer rocks on Venus or Titan, so we have to infer composition, form, texture and process from remotely-captured images and sparse chemical and spectral data. We will consider the origin of the solar system, the formation and evolution of planetary bodies, and the role of impacts, volcanism, tectonics and geomorphology in shaping them. We will summarize basic geological concepts of stratigraphy, structure and chronology and show how they can be applied off-world. We will review solar system exploration, and will include planetary data in lab exercises. This course is in the Solid Earth group for the Geosciences major.

Requirements/Evaluation: Periodic short quizzes, reading journal, lab exercises, class participation

Prerequisites: any 100-level GEOS or any 100-level ASTR course, or permission of instructor

Enrollment Limit: 20

Enrollment Preferences: Geosciences majors, Astronomy/Astrophysics majors, and sophomores

Expected Class Size: 12

Grading: yes pass/fail option, yes fifth course option
Distributions: (D3)

This course is cross-listed and the prefixes carry the following divisional credit:
ASTR 217 (D3) GEOS 217 (D3)

Attributes: GEOS Group C Electives - Solid Earth

Not offered current academic year

GEOS 220 (F) Evolution of and on Volcanic Islands (WS)

Cross-listings: GEOS 220 ENVI 219

Primary Cross-listing

Plate tectonic theory accounts for the vast majority of volcanic islands in ocean basins. They form above mantle plume hot spots (Hawaiian and Galapagos Islands), subduction zones (Aleutian and Indonesian arcs), and mid-ocean ridges (Azores and Ascension Island). Iceland is unusual because it is located above a hot spot and the mid-Atlantic ridge. Each plate tectonic setting produces chemically distinctive magmas, and the lifespan of volcanic islands varies widely. Islands above hot spots may be geographically remote and emergent for only several million years, but be part of a long-lived sequence of islands that persists for over a hundred million years. In contrast, island arc volcanoes belong to long geographically continuous chains of volcanoes, commonly in close proximity to continents. This tutorial explores the geologic evolution and lifespan of volcanic islands from formation to submergence, and searches for correlations between these characteristics and plate tectonic setting. We will also consider how geographic isolation, areal extent, lifespan, and climate affect biological evolution on volcanic islands. There will be weekly tutorial meetings with pairs of students, and students will alternate writing papers on assigned topics. This course is in the Solid Earth group for the Geosciences major.

Class Format: Remote, one-hour weekly meetings with tutorial partner and instructor

Requirements/Evaluation: five 5-page papers and critiques of partner’s papers

Prerequisites: 100-level GEOS course or permission of instructor

Enrollment Limit: 10

Enrollment Preferences: Geosciences majors and students with a demonstrated interest in geosciences

Expected Class Size: 10

Grading: no pass/fail option, no fifth course option

Distributions: (D3) (WS)

This course is cross-listed and the prefixes carry the following divisional credit:
GEOS 220 (D3) ENVI 219 (D3)

Writing Skills Notes: Students will write five 5-page papers and will receive instructor feedback on how to improve their writing skills and formulate sound arguments.

Attributes: ENVI Natural World Electives GEOS Group C Electives - Solid Earth

Fall 2020

TUT Section: RT1 TBA Paul M. Karabinos

GEOS 221 (F) Examining Inconvenient Truths: Climate Science meets U.S. Senate Politics (WS)

Cross-listings: GEOS 221 ENVI 222 LEAD 221

Primary Cross-listing

Former President Barack Obama once said: “There's one issue that will define the contours of this century more dramatically than any other, and that is the urgent threat of a changing climate.” While consensus regarding the causes and impacts of climate change has been growing steadily among scientists and researchers (and to some extent, the general public) over the past two decades, the U.S. has yet to confront this issue in a manner consistent with its urgency. This lack of action in the U.S. is at least partly due to the fact that science provides necessary but insufficient information towards crafting effective climate change legislation and the unfortunate fact that climate change has become a highly partisan issue. The primary objective of this tutorial will be to help students develop a greater understanding of the difficulties associated with crafting climate change legislation, with an emphasis on the role of science and politics within the legislative process. To this end, the tutorial will address how the underlying scientific complexities embedded in most climate policies (e.g., offsets, carbon capture and sequestration, uncertainty and complexity of the climate system,
leakage) must be balanced by and blended with the different operational value systems (e.g., economic, social, cultural, religious) that underlie U.S. politics. Over the course of this tutorial, students will develop a nuanced sense of how and when science can support the development of comprehensive national climate change legislation within the current partisan climate. This course will take a practical approach, where students will craft weekly policy oriented documents (e.g., policy memos, action memos, research briefs) targeted to selected members of the current U.S. Senate Environment and Public Works Committee, the committee that has historically held jurisdiction over a majority of the major climate change bills that have moved through the legislative process. This course is in the Oceans and Climate group for the Geosciences major.

Class Format: Hybrid: this class will be mostly remote, but there may be some in-person meetings outside for those on campus and interested, weather permitting.

Requirements/Evaluation: weekly papers (2 - 5 pages in length) and a final oral presentation
Prerequisites: none
Enrollment Limit: 10
Enrollment Preferences: sophomores, Geosciences and Environmental Studies juniors and seniors
Expected Class Size: 10
Grading: no pass/fail option, no fifth course option
Distributions: (D3) (WS)

This course is cross-listed and the prefixes carry the following divisional credit:
GEOS 221 (D3) ENVI 222 (D3) LEAD 221 (D3)

Writing Skills Notes: You will learn to write in a variety of policy-focused formats
Attributes: ENVI Environmental Policy EXPE Experiential Education Courses GEOS Group A Electives - Climate + Oceans

Fall 2020
TUT Section: RT1 TBA Alex A. Apotsos

GEOS 234 (S) Introduction to Materials Science (QFR)

Cross-listings: GEOS 234 PHYS 234

Secondary Cross-listing

Materials Science is the study of how the microscopic structure of materials—whether steel, carbon fiber, glass, wood, plastic, or mayonnaise—determines their macroscopic mechanical, thermal, electric, and other properties. Topics of this course include classifying materials; material structure; thermodynamics and phase transformations; material properties and testing; how solids bend, flow, and ultimately break; and how to choose the right material for design applications. Materials Science is a highly interdisciplinary field and as a result the course prerequisites are broad but also flexible. Interested students who are unsure about their preparation are strongly encouraged to contact the instructor.

Class Format: lecture (3 hours per week) plus three to four small-group laboratory sessions throughout the semester (to be scheduled with instructor)

Requirements/Evaluation: weekly problem sets, class participation, and midterm and final exams, all of which have a substantial quantitative component
Prerequisites: high school physics and chemistry, preferably at the AP level, and MATH 140 or AP Calculus (BC), and one 200-level PHYS, CHEM, or GEOS course; or permission of instructor
Enrollment Limit: 20
Enrollment Preferences: based on students' scientific background and seniority
Expected Class Size: 10
Grading: yes pass/fail option, yes fifth course option
Unit Notes: This course does not count toward the Geosciences major.
Distributions: (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
GEOS 234 (D3) PHYS 234 (D3)

Attributes: MTSC Courses

Not offered current academic year
GEOS 245  (F)  Hydrothermal Vents  (WS)

Cross-listings: GEOS 245  MAST 245  ENVI 245

Primary Cross-listing

Hydrothermal vents are perhaps the most alien places on Earth. Many are located on active volcanoes, especially at mid-ocean ridges, where magma super-heats water to form underwater hot springs. Others are located at deep-sea fracture zones, where the exothermic reaction of serpentinization provides the heat to drive hydrothermal circulation. Hydrothermal vents are extreme environments which host unique organisms, like giant tubeworms and giant hydrothermal clams, that are found only at these deep sea oases. This tutorial will examine how and where hydrothermal vents form, the strange and ancient life there, and why they are relevant despite feeling so far removed from our daily lives. Hydrothermal vent science draws on geology, physics, chemistry, and biology, so prior interest or coursework in one or more of those fields is suggested. This course is in the Oceans and Climate group for the Geosciences major.

Class Format: This class will meet remotely. Students will meet in pairs weekly with the instructor for one hour. The entire class will meet once at the beginning of the semester for organizational purposes and at the end of the semester for a synthesis.

Requirements/Evaluation: Five 5-page papers, critiques of tutorial partner's papers, final reflection, and participation

Prerequisites: none, open to all students

Enrollment Limit: 10

Enrollment Preferences: 1. sophomores, 2. first-years, 3. junior and senior GEOS majors and MAST concentrators

Expected Class Size: 10

Grading: no pass/fail option, no fifth course option

Distributions: (D3)  (WS)

This course is cross-listed and the prefixes carry the following divisional credit:
GEOS 245 (D3) MAST 245 (D3) ENVI 245 (D3)

Writing Skills Notes: Students will write six 5-page papers. The first five papers will be written every other week, alternating with a tutorial partner. Students will receive oral and written feedback during a discussion with the instructor and their tutorial partner. Students will write a final 5-page reflection paper to synthesize their learning.

Attributes: ENVI Natural World Electives  GEOS Group A Electives - Climate + Oceans  MAST Interdepartmental Electives

Fall 2020
TUT Section: RT1  TBA  Lisa A. Gilbert

GEOS 250  (S)  Climate,Tectonics, and Erosion  (WS)

Traditionally tectonics investigated processes operating deep in the crust and mantle, whereas geomorphology focused on surficial processes that shape the landscape. This course explores the complex interactions between tectonic and surficial processes. It has long been recognized that crustal uplift during mountain building creates new landscapes, but we now suspect that variations in erosion rate can fundamentally influence the development of mountains. Climate plays a central role in this feedback loop; the rise of mountains can change climate, and such changes can alter regional erosion rates. This course will examine how geologists use characteristic markers to estimate the amount of surface uplift, methods for determining uplift rate, surface response to faulting and folding, measuring displacement of the crust with GPS and interferometry methods, how mountain building affects erosion and exhumation rates, the limits to relief in mountains, and the interaction between mountains and climate. This course is in the Solid Earth group for the Geosciences major.

Class Format: Remote. After an initial group meeting, students will meet in pairs for one hour each week with the instructor; each student will orally present a written paper every other week for criticism during the tutorial session

Requirements/Evaluation: five 4- to 5-page papers based on journal articles

Prerequisites: at least one of the following courses: GEOS 101, 102, 103, 202, 203, 215, 302, 303, 303 or permission of instructor

Enrollment Limit: 10

Enrollment Preferences: Geosciences majors and students with a strong interest in Geosciences

Expected Class Size: 10

Grading: no pass/fail option, no fifth course option
Writing Skills Notes: Five 4- to 5-page papers distributed throughout the semester. Students will receive from the instructor timely comments on their writing skills, with suggestions for improvement.

Attributes: GEOS Group C Electives - Solid Earth

Spring 2021
TUT Section: RT1 TBA Paul M. Karabinos

GEOS 255 (F) Environmental Observation

Cross-listings: ENVI 255 GEOS 255

Primary Cross-listing
To study the environment, we need to observe and measure it. We collect data--numbers that represent system states--and analyze them to create understanding of the world we live in. Advances in technology create more opportunities to discover how the planet works. Through a survey of observational approaches (including weather stations, direct sampling, radar, community-based monitoring, and other techniques), this course will investigate the process of turning a physical property in the environment into a number on a computer and then into meaningful information. We will explore both direct field measurements and remote sensing techniques, diving into how to choose the appropriate sensor for a scientific question, how sensors work, analysis approaches and statistical methods, and how to interpret the resulting data. We will also learn how to mitigate measurement bias through a combination of lab experiments and field work and how to make interpretations of measurements that accurately reflect what is being measured. The course will focus on the near-surface environment, including the atmosphere, water, and biosphere. Students will carry out a research project using observation techniques covered in class to explore a scientific question of interest. This course is in the Oceans and Climate group for the Geosciences major.

Requirements/Evaluation: labs, quizzes, and a final project
Prerequisites: at least one prior course in GEOS or ENVI
Enrollment Limit: 20
Enrollment Preferences: sophomores
Expected Class Size: 10
Grading: no pass/fail option, no fifth course option
Distributions: (D3)
This course is cross-listed and the prefixes carry the following divisional credit:
ENVI 255 (D3) GEOS 255 (D3)
Attributes: ENVI Natural World Electives EVST Methods Courses EXPE Experiential Education Courses GEOS Group A Electives - Climate + Oceans
Not offered current academic year

GEOS 257 (F) Coastal Communities and Climate Justice (DPE)

Cross-listings: PSCI 256 GEOS 257 MAST 267 ENVI 267

Secondary Cross-listing
Climate change poses extraordinary challenges to our country's coastal communities; the impacts of which will not be borne equally. Access to innovative technological, scientific, financial and legal resources is controlled by policy makers. Equal access is critical for the sustainability of our coastal communities. But fair decisions require vulnerable communities to have a voice in local climate change adaptation decisions. This seminar course will introduce you to basic concepts of climate justice in the context of our Nation's coastal communities, guided by the UN Framework Convention on Climate Change. The course will introduce you to fundamental coastal and ocean-based climate-induced impacts with a focus on sea level rise, ocean warming, ocean acidification and coastal infrastructure. We will examine these impacts, as well as local, state, regional and federal policy responses to them through the lens of climate justice. We will identify what's working and what more needs to be done to advance climate equity and justice in the wake of formidable global and local change. Proficiency will be demonstrated through class participation, work conducted in small group strategy exercises, discussion board posts, short research assessment papers and a final written project. There are three goals in this course: first to broaden your understanding of the disproportionate effects of climate change to underrepresented, disempowered, poor, urban and indigenous
populations living in American coastal communities; second to provide you with tools to identify inequity; third, to increase your own voice to promote avenues to seek climate justice.

Class Format: remote

Requirements/Evaluation: Weekly Readings; Class Participation; Small group strategy exercises; Four on-line discussion board posts; Two 2-3-page data & research assessment papers; Final written project--multiple formats available

Prerequisites: none

Enrollment Limit: 20

Enrollment Preferences: first-years and sophomores

Expected Class Size: 15

Grading: yes pass/fail option, no fifth course option

Unit Notes: social science; This course does not count toward the Geosciences Major.

Distributions: (D2) (DPE)

This course is cross-listed and the prefixes carry the following divisional credit:

PSCI 256 (D2) GEOS 257 (D2) MAST 267 (D2) ENVI 267 (D2)

Difference, Power, and Equity Notes: This course examines the persistent disproportionate climate changes impacts on underrepresented, poor, urban and indigenous populations living in U.S. coastal communities. Students will analyze multi-disciplinary data and conduct research to reveal unequal distributions of power and resources and to strengthen their integrative, analytical, writing, and advocacy skills. They will structure discussions on the perversiveness of climate injustice and craft potential avenues for corrective actions.

Attributes: ENVI Humanities, Arts + Social Science Electives ENVI Environmental Policy MAST Interdepartmental Electives

Fall 2020

SEM Section: R1 MR 3:15 pm - 4:30 pm Catherine Robinson Hall

GEOS 272 (S) Earth Hazards and Risks (WS)

Cross-listings: ENVI 272 GEOS 272

Primary Cross-listing

As individuals, communities, and societies we live with risk from a variety of natural hazards. Depending on where we live, we may be more at risk from hurricanes, volcanoes, earthquakes, flooding, landslides, drought, wildfire, asteroids, or other hazards. Which hazards can be predicted? How far in advance and with what uncertainty? How we evaluate our risks from hazards is important for how we make decisions for ourselves and how we engage with others in decision-making. In this tutorial, we will examine the innovative ways earth scientists currently forecast these hazards. Students will use geospatial and time series data to assess the comparative risks of several hazards at a location that is significant to them (e.g., hometown, site of personal/historical importance). We will combine forecasting effectiveness with vulnerability assessments to strategize ways of proactively mitigating risk. This course is in the Sediments and Life group for the Geosciences major.

Class Format: This class will meet remotely. Students will meet in pairs or small groups weekly with the instructor for one hour. The entire class will meet once at the beginning of the semester for organizational purposes and at the end of the semester for a synthesis.

Requirements/Evaluation: Assessment will be based on participation, tutorial papers, peer reviews, presentations, and a final paper.

Prerequisites: none

Enrollment Limit: 10

Enrollment Preferences: sophomores, Geosciences and Environmental Studies juniors and seniors

Expected Class Size: 10

Grading: no pass/fail option, no fifth course option

Distributions: (D3) (WS)

This course is cross-listed and the prefixes carry the following divisional credit:

ENVI 272 (D3) GEOS 272 (D3)

Writing Skills Notes: Students will write four (5 page) tutorial papers evaluating the predictability/uncertainty of Earth-related hazards and make short (5 minute) presentations assessing risk of the hazard in their hometown or other location. A final (10 page) paper will synthesize two of the hazards
and ability of forecasts to mitigate associated risks. Students will give/receive feedback in the form of peer reviews and receive frequent feedback from the instructor.

**Attributes:** ENVI Natural World Electives  GEOS Group B Electives - Sediments + Life

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**Spring 2021**

**TUT Section:** RT1  TBA  Lisa A. Gilbert

**GEOS 302  (S) Sedimentology  (WS)**

Sedimentology is a fundamental component of Geoscience, linking the solid Earth, ocean, atmosphere and biosphere. Sediments and sedimentary rocks preserve information about the rocks that were eroded to form them, the fluids and forces that transported them, the mechanisms by which they were deposited, and the processes by which they were lithified. They are the book in which we read the story of evolution and where Earth's history is recorded. This course introduces the principles of sedimentology, including sediment composition, fluid mechanics, bedform analysis, and depositional environments. This course is in the Sediments and Life group for the Geosciences major.

**Class Format:** discussion three hours per week and laboratory three hours per week; field trips: two half-day and one all-day

**Requirements/Evaluation:** lab work, writing assignments, participation in discussions, and regular quizzes

**Prerequisites:** at least one course in GEOS Group B (Solid Earth) AND one course in GEOS Group C (Sediments and Life); or permission of instructor

**Enrollment Limit:** 15

**Enrollment Preferences:** Geosciences majors

**Expected Class Size:** 12

**Grading:** no pass/fail option, no fifth course option

**Distributions:** (D3)  (WS)

**Writing Skills Notes:** Weekly 2-3 page writing assignments will be thoroughly edited for style, grammar, and syntax; each student will compile their papers as a growing body of work, and each new assignment will be read and edited in the context of previous submissions.

**Attributes:** EXPE Experiential Education Courses  GEOS Group B Electives - Sediments + Life  MAST Interdepartmental Electives

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**Not offered current academic year**

**GEOS 303  (S) Igneous and Metamorphic Petrology**

Using plate tectonics and the geologic assembly of New England as a template, this course explores the origin of crystalline rocks--volcanic, plutonic, and metamorphic--that comprise 94% of the Earth's crust. Field and lab studies are the crux of the course, supported by experimental work and thermodynamic principles. Chemical and mineralogical compositions and rock fabrics provide evidence for crystallization environments and tectonic settings, past and present. This course is in the Solid Earth group for the Geosciences major.

**Class Format:** Hybrid; discussion, three hours per week and laboratory, two hours per week; several field trips during lab hours if COVID conditions allow.

**Requirements/Evaluation:** lab work, one hour test, and a final exam

**Prerequisites:** GEOS 202 or permission of instructor

**Enrollment Limit:** 10

**Enrollment Preferences:** GEOS majors

**Expected Class Size:** 7

**Grading:** yes pass/fail option, no fifth course option

**Distributions:** (D3)

**Attributes:** GEOS Group C Electives - Solid Earth

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**Spring 2021**

**LEC Section:** H1  MWF 8:15 am - 9:30 am  Bud Wobus

**LAB Section:** H2  T 1:00 pm - 3:00 pm  Bud Wobus
GEOS 305 (F) Geomorphology

Cross-listings: GEOS 201 ENVI 205 GEOS 305

Primary Cross-listing

Geomorphology is the study of landforms, the processes that shape them and the rates at which these processes change the landscape in which we live. The course is designed for Geosciences majors and for environmental studies students interested in the evolution of Earth's surface and the ways our activities are changing the physical environment. We will emphasize the influence of climatic, tectonic, and volcanic forces on landform evolution over relatively short periods of geologic time, generally thousands to a few millions of years. More recently, the impacts of human activity in reshaping landscapes, determining the movement of water, and changing climate could not be clearer. We will also examine how these impacts are affecting communities, including causes and possible solutions to environmental injustice. And we will learn a range of practical skills for describing physical environments and for predicting how they change, including field surveys, GIS analysis, and numerical modelling. This course is in the Sediments and Life group for the Geosciences major.

Class Format: lecture, three hours per week and laboratory, three hours per week

Requirements/Evaluation: weekly lab exercises, a research project, and a midterm and final exam

Prerequisites: At least one 100-level and one 200-level GEOS or ENVI course or permission of instructor

Enrollment Limit: 18

Enrollment Preferences: GEOS and ENVI majors

Expected Class Size: 18

Grading: yes pass/fail option, yes fifth course option

Distributions: (D3)

This course is cross-listed and the prefixes carry the following divisional credit:

GEOS 201 (D3) ENVI 205 (D3) GEOS 305 (D3)

Attributes: AMST Space and Place Electives ENVI Natural World Electives EVST Environmental Science EXPE Experiential Education Courses GEOS Group B Electives - Sediments + Life

Not offered current academic year

GEOS 309 (F) Modern Climate (QFR)

Cross-listings: GEOS 309 ENVI 209

Primary Cross-listing

What will happen to the Earth's climate in the next century? What is contributing to sea level rise? Is Arctic sea ice doomed? In this course we will study the components of the climate system (atmosphere, ocean, cryosphere, biosphere and land surface) and the processes through which they interact. Greenhouse gas emission scenarios will form the basis for investigating how these systems might respond to human activity. This course will explore how heat and mass are moved around the atmosphere and ocean to demonstrate how the geographic patterns of climate change arise. We will also focus on climate feedback effects--like the albedo feedback associated with sea ice and glacier loss--and how these processes can accelerate climate change. In labs we will learn MATLAB to use process and full-scale climate models to investigate the behavior of these systems in response to increasing greenhouse gasses in the atmosphere. This course is in the Oceans and Climate group for the Geosciences major.

Class Format: Lectures will be held synchronously online. Labs will be remote and in small groups. Lab groups will each meet online for two 1-hour sessions each week, scheduled according to the needs of the class. In-person office hours available.

Requirements/Evaluation: 4 multi-week lab projects and several short quizzes

Prerequisites: Any of GEOS 100, GEOS 103, ENVI 102, GEOS 215, or permission of instructor

Enrollment Limit: 30

Enrollment Preferences: GEOS and ENVI majors

Expected Class Size: 20

Grading: yes pass/fail option, yes fifth course option

Distributions: (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
GEOS 309 (D3) ENVI 209 (D3)

Quantitative/Formal Reasoning Notes: Labs consist of a series of numerical climate modeling projects, which require significant quantitative and logical reasoning.

Attributes: ENVI Natural World Electives EVST Environmental Science EVST Methods Courses GEOS Group A Electives - Climate + Oceans

Fall 2020
LEC Section: R1  TR 9:45 am - 11:00 am  Alice C. Bradley
LAB Section: R2  TBA  Alice C. Bradley

GEOS 312 (S) Mass Extinctions: Patterns and Processes
Over the last 542 million years of Earth history, five major mass extinctions have occurred, each dramatically changing the makeup and course of life on our planet. During some of these events, over 75% of all marine animal species went extinct and groups like the dinosaurs vanished from the planet after over 100 million years of ecological dominance. This tutorial course will explore the idea of extinction from the evolution of the concept in human thought to current research on the mechanisms and patterns of extinctions through time. We will examine what makes an extinction "mass", delve into the causes and consequences of the major mass extinction events of the phanerozoic, and discuss the potential human-induced "6th extinction" event occurring in the present day. This course is in the Sediments and Life group for the Geosciences major.

Requirements/Evaluation: four 4-5-page papers, one revision, tutorial presentations, the student's effectiveness as a critic, and 1 problem set

Prerequisites: GEOS 101 or GEOS 212; or permission of instructor + any 200 level GEOS course

Enrollment Limit: 10

Enrollment Preferences: Geosciences majors

Expected Class Size: 10

Grading: no pass/fail option, no fifth course option

Distributions: (D3)

Attributes: GEOS Group B Electives - Sediments + Life

Not offered current academic year

GEOS 314 (S) Analytical Historical Geology (QFR)
In this course you will learn to collect, interpret, and analyze deep time paleontological, stratigraphic, and sedimentological records through readings, labs, and projects all coordinated around a week long spring break trip to explore the House Range of Utah. The Cambrian and Ordovician successions of Utah's West Desert offers an outstanding record of one of the most important periods in Earth history, tracking the rise of animal ecosystems and major increases in diversity. The first 6 weeks of class will be spent learning the fundamentals of quantitative methods in paleontology and stratigraphy. Labs will focus on skill building including learning basic coding in R, and learning how to interpret paleontological, sedimentological, and stratigraphic data. We will also read widely on the field locality and on the Cambrian and Ordovician Periods. During the field trip, we will explore the House Range. Students will learn skills including geological mapping, measuring stratigraphic section, finding and identifying fossils, and correlating rock units across basins. We will collect samples and data on the field trip and bring them back to Williams. The second 6 weeks of the course will be spent processing and analyzing the samples and data collected during the field trip, culminating in final projects to be done in small groups. Students will determine what data we will collect in the field. Examples might be trilobite taxonomy and phylogenetic analyses, quantitative biostatigraphic correlation using conodont fossils, reconstructing paleoenvironment based on sedimentological analyses of thin sections, or building a sequence stratigraphic framework for a subset of the field locality. This course is in the Sediments and Life group for the Geosciences major.

Class Format: weekly lectures, paper discussions, and hands-on labs

Requirements/Evaluation: short papers and lab assignments, spring break field course participation (REQUIRED), and a final group project

Prerequisites: GEOS majors who have taken at least one of the following courses: GEOS 212, GEOS 203, GEOS 324, GEOS 401, GEOS 302, or permission of instructor

Enrollment Limit: 10

Enrollment Preferences: junior and senior Geosciences majors

Expected Class Size: 10

Grading: no pass/fail option, no fifth course option
GEOS 317 (S) Current topics in Planetary Geology  (WS)

Cross-listings: GEOS 317  ASTR 317

Primary Cross-listing
We will look in detail at geological processes on rocky and icy bodies of the Solar System. Each week will have a specific theme, and students will read a series of scientific articles on that topic. The readings will form the basis for writing and discussion. Areas to be investigated may include ice ages on Mars, the origin of Earth’s moon, tectonics on Venus, chaos terrain on Europa, geysers on Enceladus, cryovolcanism on Triton, methane lakes on Titan, the viability of mining in the Asteroid Belt, and the prospects for life on other worlds. This course is in the Solid Earth group for the Geosciences major.

Class Format: Students meet with the professor weekly, in pairs, with one student writing each week and the other critiquing; and both engaging in detailed discussion of the readings.

Requirements/Evaluation: Evaluation is based on written papers, critiques, and discussion.

Prerequisites: GEOS/ASTR 217 (Planets and Moons); OR any two courses at 200-level or higher in Geosciences and/or Astronomy; OR permission of instructor

Enrollment Limit: 10

Enrollment Preferences: Geosciences and Astronomy majors and prospective majors

Expected Class Size: 6

Grading: yes pass/fail option, yes fifth course option

This course is cross-listed and the prefixes carry the following divisional credit:
GEOS 317 (D3) ASTR 317 (D3)

Writing Skills Notes: This tutorial-style course focuses on writing, with 6 papers (5-7 pages) written bi-weekly throughout the semester, and partner critiques in alternate weeks.

Attributes: GEOS Group C Electives - Solid Earth

Spring 2021
SEM Section: HT1  Cancelled

GEOS 324 (S) Corals and Sea Level

Cross-listings: GEOS 324  MAST 324  ENVI 324

Primary Cross-listing
In coastal communities, increasing flood damage from storm surges and chronic inundation by seawater are already happening as a result of sea level rise. How do we know what contributes to the observed change in sea level in the last century? What does the geological record teach us about what controls the natural variation in sea level on short and long timescales? How can we use this information to separate anthropogenic effects from natural change in modern systems? And how does this inform us on what to expect through the 21st century and beyond? In this course, we will examine how sea level is reconstructed using geological archives and how coral-based sea level data led to breakthroughs in our understanding of the long-term evolution of the ocean and climate, the controls in the timing of ice age cycles, the singularity of modern climate change, and how high the future seas will rise. During Spring Break, the class will travel to Barbados, a renowned locality for Quaternary sea level reconstruction, to observe modern and ancient reefs, and collect samples that will be the basis of individual or group projects in the second half of the semester. Participation in the Spring Break trip is not required for successful completion of the course, but course enrollment is necessary to attend the trip. This course is in the Oceans and Climate group for the Geosciences major.

Requirements/Evaluation: short papers, labs, participation in discussion, and a research project
**Prerequisites:** GEOS 104 or GEOS 210 or GEOS 215 or MAST 311 or permission of instructor

**Enrollment Limit:** 10

**Enrollment Preferences:** Geoscience majors, students who commit to the Spring Break trip

**Expected Class Size:** 10

**Grading:** no pass/fail option, no fifth course option

**Distributions:** (D3)

This course is cross-listed and the prefixes carry the following divisional credit:
GEOS 324 (D3) MAST 324 (D3) ENVI 324 (D3)

**Attributes:** ENVI Natural World Electives  EXPE Experiential Education Courses  GEOS Group A Electives - Climate + Oceans

Not offered current academic year

**GEOS 401  (F)  Global Tectonics and the Rise of Mountains  (WS)**

Fifty years after the sea-floor spreading hypothesis was first verified using magnetic anomalies, we have spectacular data sets from paleomagnetism, seismology, volcanism, the Global Positioning System, and digital elevation models that provide rich details into the kinematics and mechanisms of present and past plate motions. We will read journal articles to explore how plate tectonics can help explain the evolution of mountain belts with special emphasis on the Appalachians.

**Class Format:** Remote, weekly one-hour meetings with tutorial partner and instructor

**Requirements/Evaluation:** five papers based on journal articles, and critiques of partner's papers

**Prerequisites:** GEOS 203, 302, or 303 or permission of instructor

**Enrollment Limit:** 10

**Enrollment Preferences:** senior Geosciences majors, then juniors

**Expected Class Size:** 10

**Grading:** no pass/fail option, no fifth course option

**Unit Notes:** As a 400-level seminar, this capstone course is intended to build on and extend knowledge and skills students have developed during previous courses in the major

**Distributions:** (D3) (WS)

**Writing Skills Notes:** Five 5-page papers throughout the semester based and journal articles. Students will receive from the instructor timely comments on their writing skills, with suggestions for improvement.

**Attributes:** GEOS Group C Electives - Solid Earth

Fall 2020

TUT Section: RT1  TBA  Paul M. Karabinos

**GEOS 404  (S)  Coastal Processes and Geomorphology  (QFR)**

**Cross-listings:** ENVI 404  MAST 404  GEOS 404

**Primary Cross-listing**

Can people live safely along the coast? Recent events like SuperStorm Sandy and the Tohoku Tsunami have shown us how the ocean can rise up suddenly and wreak havoc on our lives and coastal infrastructure. Only educated geoscientists can evaluate the risks and define informed strategies to prevent future coastal catastrophes. Currently almost half the global population lives within 100 km of the coast, with a large percent of those living in densely populated cities (e.g., New York, New Orleans, Los Angeles, Shanghai, Hong Kong, Cape Town, Sydney, Mumbai). Despite the growing risks and challenges associated with climate change and rising sea levels, the coastal population continues to grow rapidly. To help ensure these growing populations can live safely along the coast requires a detailed understanding of the processes that shape the coastal zone. These processes act across a variety of scales, from deep-time geologic processes that dictate coastal shape and structure, to decadal-scale processes that determine shoreline position and evolution, to weekly and daily processes such as storms and tides. This course will provide an in-depth look at the forces--wind, waves, storms, and people--that shape the coastal zone, as well as the geologic formations--sandy beaches, rocky cliffs, barrier islands, deltas, and coral reefs--that are acted upon and resist these forces. Coastal dynamics are strongly affected by human interventions, such as seawalls, dredged channels, and sand dune removal, as well as by sea level rise and changes in storm frequency and magnitude associated with climate change.
Finally, the course will provide students with a perspective on how the U.S. seeks to manage its coastal zone, focusing on sea level rise and coastal development. This class will include a quantitative lab that will use MATLAB software to model and evaluate various coastal processes. Students will gain a basic understanding of MATLAB functionality, and will be asked to independently apply what they have learned to various data sets provided by the instructor.

Class Format: lecture two times a week with a lab one time per week

Requirements/Evaluation: lab reports, tests, and an independent research project

Prerequisites: Either GEOS 104 or GEOS 210; or permission of instructor

Enrollment Limit: none

Enrollment Preferences: senior Geosciences majors, then juniors

Expected Class Size: 10

Grading: yes pass/fail option, yes fifth course option

Unit Notes: As a 400-level seminar, this capstone course is intended to build on and extend knowledge and skills students have developed during previous courses in the major

Distributions: (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
ENVI 404 (D3) MAST 404 (D3) GEOS 404 (D3)

Quantitative/Formal Reasoning Notes: This course will involve the use of MATLAB software to quantitatively analyze coastal process and geomorphological data.

Attributes: ENVI Natural World Electives

Not offered current academic year

GEOS 405 (F) Geochemistry: Understanding Earth's Environment

Cross-listings: ENVI 405 GEOS 405

Primary Cross-listing

Rocks, water, air, life: what comprises these interconnected components of the Earth system? How do they interact today, and how did these interactions differ in the past? In this course we will study how chemical elements are distributed in the Earth, cycle through the Earth system, and act together to produce a planet that is habitable. As Earth's landscapes and oceans, and the life they harbor, have evolved through time, they have left an imprint in the geological record that we can read using geochemical tools such as molecular fossils, elemental ratios, and stable and radioactive isotopes. Topics include the synthesis of elements in stars, the formation and differentiation of planet Earth; radiometric dating; the major constituents of the atmosphere, rain, rocks, rivers and the ocean; how they're linked by chemical weathering and biological activity; and reconstruction of past environments. Students will explore these topics through lecture; reading and discussing articles from the scientific literature; and collecting, analyzing and interpreting data from environmental samples.

Requirements/Evaluation: seminar discussions, two 10-page lab reports, lab activities, and final project

Prerequisites: two 200-level GEOS courses and at least one of GEOS 302 or 303

Enrollment Limit: 10

Enrollment Preferences: senior Geosciences majors, then juniors

Expected Class Size: 10

Grading: no pass/fail option, no fifth course option

Unit Notes: As a 400-level seminar, this capstone course is intended to build on and extend knowledge and skills students have developed during previous courses in the major

Distributions: (D3)

This course is cross-listed and the prefixes carry the following divisional credit:
ENVI 405 (D3) GEOS 405 (D3)

Attributes: ENVI Natural World Electives

Not offered current academic year
GEOS 410  (S)  The Cryosphere

Cross-listings:  ENVI 410  GEOS 410

Primary Cross-listing

The Earth's climate system is often described in terms of its spheres, including the atmosphere, biosphere, lithosphere, oceans, and the cryosphere. The cryosphere is the naturally occurring ice on Earth in all its many forms: snow, glaciers, ice sheets, sea ice, frozen lakes and rivers, and permafrost (frozen soil). These parts of the climate system may seem remote, but have implications for climate and weather around the world; changes in Arctic sea ice cover accelerate climate change in the north, resulting in the increased frequency of Polar Vortex events that send frigid temperatures down as far as the southern US. Melting glaciers and ice sheets have already contributed to sea level rise, and are projected to do so even more in the future. This course will explore the cryosphere, including snow, sea ice, permafrost, and glaciers through lectures, hands-on and data analysis labs, reading journal articles, and a final project. As a 400-level seminar, this capstone course is intended to build on and extend knowledge and skills students have developed during previous courses in the major.

Class Format: Hybrid: classes will meet synchronously online for lectures/discussions, labs will meet in person when possible. Class periods and lab periods will be used interchangeably based on the weather.

Requirements/Evaluation:  Evaluation will be based on short papers, labs responses, and a research project
Prerequisites:  GEOS 215 or GEOS 255 or GEOS 309 or MAST 311 or permission of instructor

Enrollment Limit:  10
Enrollment Preferences:  Senior GEOS majors, then other GEOS majors
Expected Class Size:  10
Grading:  yes pass/fail option,  yes fifth course option

Unit Notes:  As a 400-level seminar, this capstone course is intended to build on and extend knowledge and skills students have developed during previous courses in the major

Materials/Lab Fee:  Labs will be outside during the winter: students should be prepared to dress appropriately for the weather.

Distributions:  (D3)

This course is cross-listed and the prefixes carry the following divisional credit:
ENVI 410 (D3) GEOS 410 (D3)

Attributes:  ENVI Natural World Electives

Spring 2021

SEM Section: H1  WF 8:15 am - 9:30 am  Alice C. Bradley
LAB Section: H2  M 8:15 am - 9:30 am  Alice C. Bradley

GEOS 411  (F)  Geobiology

Geobiology--the study of interactions between earth and life over geologic timescales--is a new and interdisciplinary field that has grown out of exciting advances in earth and life sciences. During this course we will examine the many ways in which organisms -- from bacteria to trees -- have left their mark on our planet. Topics include the origin of life, the rise of oxygen in the earth's atmosphere, the evolution of biomineralization, the environmental context for animal evolution, the role of microbial communities in the earth system, the emergence of land plants, and the potential for planet-life interactions elsewhere in our solar system. Geobiology incorporates tools and ideas from geochemistry, paleontology, microbiology, and sedimentology. Class time will be divided between lectures and student-led discussions of primary literature. Labs will be varied and involve everything from growing our own microbial ecosystems to querying online databases and analyzing geological, geochemical, genetic, and paleontological data. Our field trip will take us to Upstate New York where we will sample water from a stratified lake and visit ancient microbial fossil reefs. The final project will involve writing a proposal in small groups on a geobiological topic based on the style and format of a National Science Foundation grant, and presenting the idea to the class.

Requirements/Evaluation:  labs, short papers, final grant proposal and presentation
Prerequisites:  GEOS 212 or GEOS 312T; or GEOS 101 + any 200-level GEOS course; or permission of instructor
Enrollment Limit:  15
Enrollment Preferences:  senior Geosciences majors, then juniors
Expected Class Size:  10
Grading:  no pass/fail option,   yes fifth course option

Unit Notes: As a 400-level seminar, this capstone course is intended to build on and extend knowledge and skills students have developed during previous courses in the major

Distributions:  (D3)

Attributes:  EXPE Experiential Education Courses

Not offered current academic year

GEOS 493 (F) Senior Thesis: Geosciences
Geosciences senior thesis; this is part of a full-year thesis (493-494).
Grading:  no pass/fail option,   no fifth course option
Distributions:  (D3)

Fall 2020
HON Section: H1  TBA  Mea S. Cook

GEOS 494 (S) Senior Thesis: Geosciences
Geosciences senior thesis; this is part of a full-year thesis (493-494).
Grading:  no pass/fail option,   no fifth course option
Distributions:  (D3)

Spring 2021
HON Section: H1  TBA  Mea S. Cook

GEOS 497 (F) Independent Study: Geosciences
Geosciences independent study.
Grading:  no pass/fail option,   no fifth course option
Distributions:  (D3)

Fall 2020
IND Section: H1  TBA  Mea S. Cook

GEOS 498 (S) Independent Study: Geosciences
Geosciences independent study.
Grading:  no pass/fail option,   no fifth course option
Distributions:  (D3)

Spring 2021
IND Section: H1  TBA  Mea S. Cook

Winter Study -----------------------------------------------

GEOS 22 (W) Geosciences Research
Students will spend part of Winter Study doing fieldwork collecting data. Back at Williams, they will analyze the data. Each student will have responsibility for a subset of the data, and the individual sub-projects will contribute to the overall research.
Class Format: to be arranged with instructor
Requirements/Evaluation: final project
Prerequisites: two Geosciences courses; permission of the instructor required before registering for the course
Enrollment Limit: 3
Expected Class Size: 3
Grading: pass/fail only

Not offered current academic year

GEOS 31  (W) Senior Thesis: Geosciences
To be taken by students registered for Geosciences 493-494.
Class Format: thesis
Grading: pass/fail only
Distributions: (D3)

Not offered current academic year

GEOS 99  (W) Independent Study: Geosciences
Open to upperclass students. Students interested in doing an independent project (99) during Winter Study must make prior arrangements with a faculty sponsor. The student and professor then complete the independent study proposal form available online. The deadline is typically in late September. Proposals are reviewed by the pertinent department and the Winter Study Committee. Students will be notified if their proposal is approved prior to the Winter Study registration period.
Class Format: independent study
Grading: pass/fail only

Not offered current academic year