Term Information

Effective Term	Spring 2019
Previous Value	*Autumn 2018*

Course Change Information

What change is being proposed? (If more than one, what changes are being proposed?)

Change the level from 4310 to 5310

What is the rationale for the proposed change(s)?

The proposed change of the course to a 5000-level course would allow more analytical or technical materials of geodetic and passive remote sensing to be covered, to better prepare students who wish to advance to PhD studies, or to seek technical jobs after they graduated with an advanced degree. The more advanced settings of the course would allow students to learn detailed science and applications using the observations and the associated data processing methodologies.

What are the programmatic implications of the proposed change(s)?

(e.g. program requirements to be added or removed, changes to be made in available resources, effect on other programs that use the course)?

The proposed change of the course to 5000-level would allow the graduate students in our School to take the course for credits in their respective graduate programs.

Is approval of the requrest contingent upon the approval of other course or curricular program request? No

Is this a request to withdraw the course? No

General Information

Course Bulletin Listing/Subject Area	Earth Sciences
Fiscal Unit/Academic Org	School of Earth Sciences - D0656
College/Academic Group	Arts and Sciences
Level/Career	Graduate, Undergraduate
Previous Value	*Undergraduate*
Course Number/Catalog	5310
Previous Value	*4310*
Course Title	Remote Sensing in the Earth Sciences
Transcript Abbreviation	Rmte Sens EarthSci
Course Description	The overall learning of geodetic (active) and passive remote sensing technologies and in-depth data analytics of their processing to apply to research in Earth sciences and engineering. This course is focused on students learning the theory and data processing methods to enable the use of contemporary satellite or airborne platform-equipped observations for science and engineering applications.
Previous Value	*Acquisition, processing and analysis of satellite and airborne remote sensing data. Includes visible band to microwave (e.g., MODIS, LandSat, and SAR). Also includes geodetic measurements such as altimetry and gravity.*
Semester Credit Hours/Units	Fixed: 3

Offering Information

Length Of Course	14 Week, 12 Week, 8 Week, 7 Week, 6 Week
Flexibly Scheduled Course	Sometimes
Does any section of this course have a distance education component?	No
Grading Basis	Letter Grade

Repeatable	No
Course Components	Lecture
Grade Roster Component	Lecture
Credit Available by Exam	No
Admission Condition Course	No
Off Campus	Never
Campus of Offering	Columbus

Prerequisites and Exclusions

Prerequisites/Corequisites	Prereq: 1121, and Math 1141 or 1151 or above, and Physics 1250 or above, or permission of the instructor, or grad standing.
Previous Value	*Prereq: 1121, and Math 1141 or 1151 or above, and Physics 1250 or above.*
Exclusions	
Electronically Enforced	Yes

Cross-Listings

Cross-Listings

Subject/CIP Code

Subject/CIP Code	40.0699
Subsidy Level	Doctoral Course
Previous Value	*Baccalaureate Course*
Intended Rank	Junior, Senior, Masters, Doctoral
Previous Value	*Sophomore, Junior, Senior*

Requirement/Elective Designation

The course is an elective (for this or other units) or is a service course for other units

Course Details

Course goals or learning objectives/outcomes

- Acquisition, processing and analysis of satellite and airborne remote sensing data. Includes visible band to microwave (e.g., MODIS, LandSat, and SAR). Also includes geodetic measurements such as altimetry and gravity.

Content Topic List

- Electromagnetic spectrum
- Passive and active methods
- Synthetic Aperture Radar
- Thermal imaging
- Remote sensing of water of the water cycle
- Remote sensing of vegetation
- Remote sensing in the Earth Sciences

Sought Concurrence No

Attachments

- ES4310_Syllabus_Autumn16.pdf: old syllabus

  (Syllabus. Owner: Panero,Wendy R)

- Earth Sci BS curriculum map 2018.doc: curriculum map

  (Other Supporting Documentation. Owner: Panero,Wendy R)

- Proposed EARTHSC Course Syllabus 2018.pdf: new syllabus

  (Syllabus. Owner: Panero,Wendy R)

Comments

- As discussed with BCV on the phone, I have removed the cross listing request and included an updated a curriculum map.

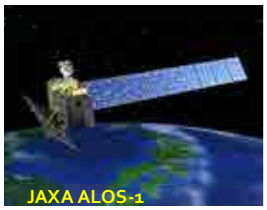
  10/1: I think I removed all references to cross listing! I amended the prerequisites as suggested. *(by Panero,Wendy R on 10/01/2018 02:35 PM)*

- 10/01/18: Please remove Geodetic Sci cross-listing info in the 1st box under Course Change Information and from the syllabus; update prereqs by adding "or Grad Standing" and/or "permission of instructor. *(by Haddad,Deborah Moore on 10/01/2018 11:21 AM)*

- - Since the course changes levels & material is added to the curriculum, it is likely that the curriculum map needs to be updated. If so, could you please provide a copy of the major(s) curriculum map(s)?
  -Note: the course catalog does not list Geodetic Science 5310. Is the intention to create that cross-listed version of the course? If so, that is likely going to be problematic for OAA since they do not want courses cross-listed within a same unit. (They have made a few exceptions, but these need to be requested ahead of time.)
  -Graduate students outside of SES can already take the 4000-level course for graduate credit. This is just fyi & I understand the wish to up the level to 5000 is also motivated by addition of material + wish for SES grad students to take the course for grad credit. *(by Vankeerbergen,Bernadette Chantal on 09/04/2018 09:17 AM)*

Workflow Information

Status	User(s)	Date/Time	Step
Submitted	Panero,Wendy R	08/31/2018 12:51 PM	Submitted for Approval
Approved	Panero,Wendy R	08/31/2018 12:51 PM	Unit Approval
Approved	Haddad,Deborah Moore	08/31/2018 07:07 PM	College Approval
Revision Requested	Vankeerbergen,Bernadette Chantal	09/04/2018 09:18 AM	ASCCAO Approval
Submitted	Panero,Wendy R	09/28/2018 04:12 PM	Submitted for Approval
Approved	Panero,Wendy R	09/28/2018 04:14 PM	Unit Approval
Revision Requested	Haddad,Deborah Moore	10/01/2018 11:21 AM	College Approval
Submitted	Panero,Wendy R	10/01/2018 02:35 PM	Submitted for Approval
Approved	Panero,Wendy R	10/01/2018 02:35 PM	Unit Approval
Approved	Haddad,Deborah Moore	10/01/2018 04:30 PM	College Approval
Pending Approval	Nolen,Dawn Vankeerbergen,Bernadette Chantal Oldroyd,Shelby Quinn Hanlin,Deborah Kay Jenkins,Mary Ellen Bigler	10/01/2018 04:30 PM	ASCCAO Approval




DoD GPS


Remote Sensing in Earth Sciences

Earth Science 4310, Autumn 2016, 3 Credit Hours

http://go.osu.edu/GeodeticRemoteSensing

Tuesday & Thursday 12:45 – 14:05 PM, Campbell Hall #243

Professor C.K. Shum & Professor Alan Saalfeld

Division of Geodetic Science, School of Earth Sciences, The Ohio State University
125 S Oval Mall, 221B and 223C Mendenhall Lab
Telephone: +1-614-292-7118, +1-614-292-6665
Office Hours: By appointments

e-Mails: ckshum@osu.edu, saalfeld.1@osu.edu
URLs: http://go.osu.edu/ckshum, http://go.osu.edu/AlanSaalfeld

Course Description

This course aims at undergraduate or graduate students interested in learning new technologies of *Geodetic Remote Sensing* and the associated *visualization tools* for cross-disciplinary sciences, including physical, environmental and social sciences, public health and engineering applications. The remote sensing platforms include aircrafts and unmanned aerial vehicles or UAVs, and a suite of contemporary Earth-orbiting satellites, launched by NASA, DoD, ESA, JAXA, CNES, ISRO, CSA, industries, etc. The deliver global, timely *big data* by sensing the Earth in space, on surface or inside the Earth. *Selected sensors* will be studied, including GPS (GNSS), altimeters, LiDAR, gravimeters, synthetic aperture radar (SAR), ground penetrating radars, magnetometers, radiometers, spectrometers, scatterometers, sounders, and optical/NIR cameras. The course is designed for students to learn the basic principles of *active* or *geodetic remote sensing*, hands-on data processing via interactive or *black-box* type of computer modules on the web or cloud, and learning the ability to address *selected* scientific, engineering, social science or public health problems, including but not limited to, analyses of natural hazards including floods and droughts, hydrology, wetland dynamics, glaciers and ice sheet ablations, sea level rise, ocean circulations, tides, tsunamis, land cover, bathymetry, digital elevation/topography models, land subsidence, earthquakes, volcanism, geodynamics, subsurface processes, space physics, atmospheric occultation, satellite precipitation, oil/gas exploration, water-related infectious diseases, agriculture and land cover, food security, harmful algal blooms, urban and city planning, population dynamics, coastal vulnerability/ resilience, water resources and disasters management, climate change adaption/mitigation.

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Autumn 2016

Pre-requisites: **Instructors'** approval, or ES 1121, Physics 1250, Math 1151, or equivalent.

Texts

There is no required text book. Lecture materials are available via the course webpage.
References: esri ArcGIS Imagery Book: https://learn.arcgis.com/en/arcgis-imagery-book/
Google Earth pro app: https://www.google.com/earth/
Google Earth Engine: https://earthengine.google.com

Course Policies

- Class Attendance: Yes. Required to attend all the lectures
- Hands-on home-work assignments require computers

Grading: Letter Graded

Assignments/Projects: 30%, Mid-Term Examination: 30%, Final Examination: 40%
A: 93–100 | **A-**: 90–92 | **B+**: 87–89 | **B**: 83–86 | **B-**: 80–82 | **C+**: 77–79
C: 73–76 | **C-**: 70–72 | **D+**: 67–69 | **D**: 60–66 | **E**: < 60

Academic Misconduct

It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-487). For additional information, see the Code of Student Conduct, http://studentlife.osu.edu/pdfs/csc_12-31-07.pdf.

Students with Disabilities

Students with disabilities that have been certified by the Office for Disability Services will be appropriately accommodated and should inform the instructor as soon as possible of their needs. The Office for Disability Services is located in 150 Pomerene Hall, 1760 Neil Avenue; T: +1-614-292-3307; TDD: +1-614-292-0901; http://www.ods.ohio-state.edu/.

Abbreviated Syllabus

Week 1 – Advent of the Space Age, history of geodesy & navigation, GPS, history of remote sensing, basic measurement and instrument concepts, Earth as a sensing object

Week 2 – Electromagnetic spectra, active and passive remote sensing, remote sensing platforms, space agencies, identifying various sensors and observables

Week 3 – Rudimentary understanding of orbital dynamics – how does a satellite work? Design of satellite orbits, measurement sampling, scientific requirements, and accuracies.

Week 4 – Google Earth/Pro, visualization tools, computational cartography and map making, GIS, graphical illustration of geophysical and spatial data, statistical analysis

Week 5 – Principles of selected geodetic sensors I, GPS/GNSS, satellite altimetry, satellite gravimetry, synthetic aperture radar (SAR), SAR Interferometry (InSAR), or Lidar

Week 6 – Principles of selected geodetic sensors II, GPS/GNSS, satellite altimetry, satellite

gravimetry, synthetic aperture radar (SAR), SAR Interferometry (InSAR), or Lidar

Week 7 – Review and Mid-Term Examination

Week 8 – Principles of selected geodetic sensors III, GPS/GNSS, satellite altimetry, satellite gravimetry, synthetic aperture radar (SAR), SAR Interferometry (InSAR), or Lidar

Week 9 – Principles of selected geodetic sensors IV, GPS/GNSS, satellite altimetry, satellite gravimetry, synthetic aperture radar (SAR), SAR Interferometry (InSAR), or Lidar

Week 10 – Science or application I: Remote sensing of the ocean or solid Earth

Week 11 – Science or application II: Remote sensing of terrestrial water bodies, public health

Week 12 – Science or application III: Remote sensing of hazards, social science and resilience

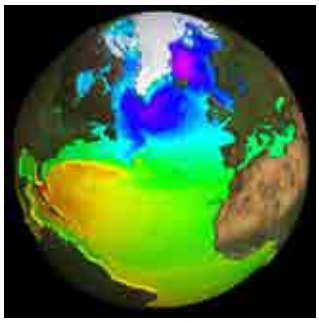
Week 13 – Science or application IV: Remote Sensing of the land cover or atmosphere

Week 14 – Review for Final Examination

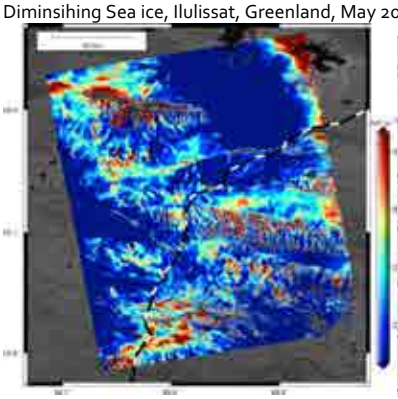
Homework Assignments/Project: Project: students select their preferred remote sensing observations aided scientific (physical, social or public health) or engineering applications.

Diminsihing Sea ice, Ilulissat, Greenland, May 2013

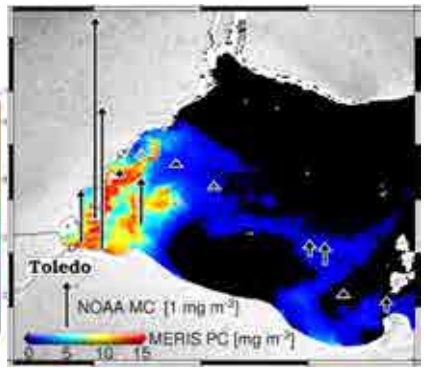
Issyk-kul endorheic Lake, Kyrgyzstan, facing Tien Shan



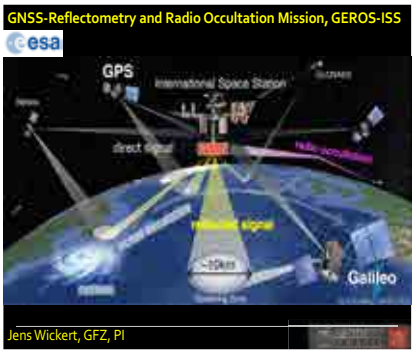
Altimetry dynamic topography (CNES)



Tibet permafrost degradation from ALOS InSAR



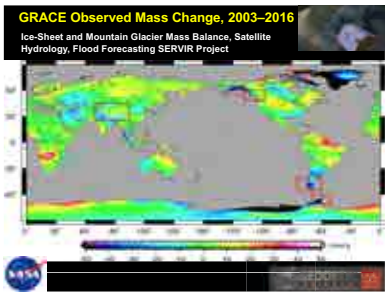
Western Lake Erie harmful algae bloom sensing



GNSS Reflectometry on International Space Station

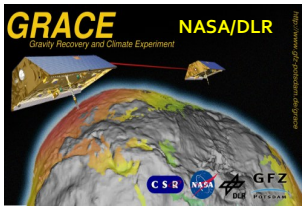
Juneau ice field, Alaska

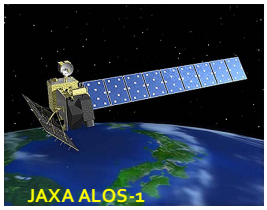
Bangladesh delta coastal vulnerability

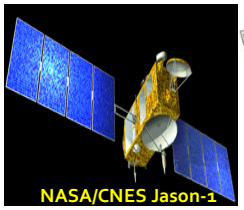


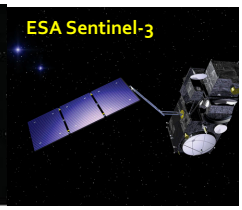
GRACE observed Earth mass transports

GPS Monitoring of solid Earth Deformations, Ilulissat, Greenland, May 2013









Request of Course Change
From EARTHSC 4310 to EARTHSC 5310

Remote Sensing in Earth Sciences

EARTHSC 5310, 3 Credit Hours

Autumn Semesters proposed start on Autumn 2019
Tuesday & Thursday 12:45 – 14:05 PM

C.K. Shum and Alan Saalfeld

Division of Geodetic Science, School of Earth Sciences, The Ohio State University
125 S Oval Mall, 221B and 223C Mendenhall Lab
Telephone: +1-614-292-7118, +1-614-292-6665
Office Hours: By appointments

Emails: ckshum@osu.edu, saalfeld.1@osu.edu
URLs: http://go.osu.edu/ckshum, http://go.osu.edu/AlanSaalfeld

August 31, 2018

Syllabus

Concise Course Description (<400 characters)

This course aims at undergraduate or graduate students interesting in the overall learning of geodetic (active) and passive remote sensing technologies and in-depth data analytics of their processing to apply to research in Earth sciences and engineering. This course is focused on students learning the theory and data processing methods to enable the use of contemporary satellite or airborne platform-equipped observations for science and engineering applications.

Course Description

This course aims at undergraduate or graduate students interested in learning and applying new technologies of remote sensing, including remote sensing from Earth-orbiting satellites, data analyses and scientific interpretations, for studying cross-disciplinary Earth sciences.

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Students will learn basic principles of passive and active remote sensing, including visualization tools (Google Earth, Bing Maps, OpenStreetMap, and others), to enable generating observations to study state of the Earth's environment, ecology, hydrology, glaciology, oceanography, energy exploration, and climate change. In addition, the analysis tools will enable the students to conduct hands-on analysis of these Big Data sets for disasters and water resources management, location services, precision farming, public health, sustainability, energy, smart city/mobility, and other cross-disciplinary applications. Specifically, hands-on processing of these freely available satellite data sets via interactive cloud-based APIs (*Application Programming Interfaces*), or black-box type of computer modules with little or no extensive learning. These data sets are from scientific and commercial satellites launched by international space agencies and industries, which deliver global and near-real time observations by sensing the Earth from space, on or inside Earth's surface. These remote sensing platforms include aircraft and unmanned aerial vehicles or UAVs, GPS (GNSS), altimeters, LiDAR, gravimeters, synthetic aperture radar (SAR), ground penetrating radars, magnetometers, radiometers, spectrometers, scatterometers, sounders, and optical/NIR/multispectral cameras.

Pre-requisites

Instructors' approval; or ES 1121, Physics 1250, Math 1141 or 1151, or equivalent.

Heritage

This course proposal is based and upgraded from an existing course EARTHSC 4310, *Remote Sensing in Earth Sciences*, http://go.osu.edu/GeodeticRemoteSensing.

Text Book

There is no required text book. Lecture materials are available on Carmen-Canvas, and via instructors-developed and online materials.

References

ESRI ArcGIS Imagery Book: https://learn.arcgis.com/en/arcgis-imagery-book/
Google Earth Pro: https://www.google.com/earth/
Google Earth Engine: https://earthengine.google.com
OpenStreetMap: https://www.openstreetmap.com
The Generic Mapping Tools (GMT): https://www.soest.hawaii.edu/gmt
OpenMapTiles: https://openmaptiles.com/satellite
Blue Marble Maps: http://www.bluemarblegeo.com/products/global-mapper.php

Course Policies

- Class Attendance: Students are required to attend all the lectures
- Hands-on home-work assignments require computers

Grading: Letter Grades

Assignments/Projects: 30%, Mid-Term Examination: 30%, Final Examination: 40%
A: 93–100 | **A-**: 90–92 | **B+**: 87–89 | **B**: 83–86 | **B-**: 80–82 | **C+**: 77–79
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Syllabus (Class presentations, exams, and home works available upon request)

Week 1 – Course Objectives. Advent of the Space Age, history of geodesy & navigation, GPS, history of remote sensing, basic measurement and instrument concepts, Earth as a sensing object

Week 2 – Earth Sciences & Applications Using Remote Sensing. Selected examples.

Week 3 – Principles of Remote Sensing. Electromagnetic spectra, active and passive remote sensing, remote sensing platforms, space agencies, identifying various sensors and observables

Week 4 – Principles of Satellites. Rudimentary understanding of orbital dynamics – how does a satellite work? Gravity and satellite orbits. Design of satellite orbits, measurement sampling, scientific requirements, and accuracies

Week 5 – Different Satellite Orbits & Remote Sensing Platforms. Cubesats, nanosats, UAV, airborne platforms

Week 6 – Mapping, Visualization Tools, & Analysis Tools. Google Earth Pro, Bing Maps, Open Street Maps, Google Earth Engine, visualization tools, computational cartography and map making, online ArcView, GMT, Blue Marble Mapping, Open MapTiles, map projections, graphical illustration of geophysical and spatial data, statistical analysis

Week 7 – Review and Mid-Term Examination

Week 8 – Optical, Multi-/Hyperspectral, Stereo Photogrammetry. Principles of multi-spectral land cover classification, water and water quality sensing. Examples using Landsat, MODIS, high-resolution imageries

Week 9 – Principles of GPS/GNSS & Its Interdisciplinary Applications. Positioning, mobile phone triangulation, location services, geodynamics, meteorology, geophysics, water level, precision farming

Week 10 – Digital Elevation Model (DEM) and Digital Surface Model (DSM). Synthetic aperture radar (SAR), stereo InSAR, repeat-pass SAR Interferometry (InSAR), Lidar

Week 11 – Satellite Altimetry & Its Applications. Oceanography, glaciology, hydrology, solid Earth, atmosphere, snow

Week 12 – Satellite Gravimetry & Its Applications. Oceanography, glaciology, hydrology, solid Earth, earthquakes, subsurface, atmosphere, snow

Week 13 – Cross-disciplinary Applications: Select from public health, Smart Cities, mobility, social sciences, climate change, Weather forecasting, cyclones, storm surges, land subsidence, location services, logistics

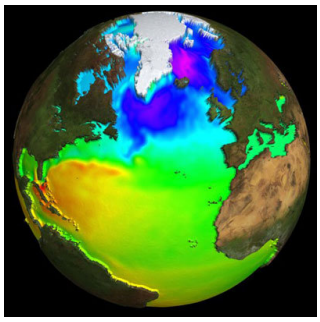
Week 14 – Review & Final Examination

Homework Assignments: 1. Satellite orbits and visualizations. **2.** Multispectral landcover or water classifications (Landsat, MODIS, or PlanetScope imageries). **3.** Satellite altimetry sensing of ocean and rivers.

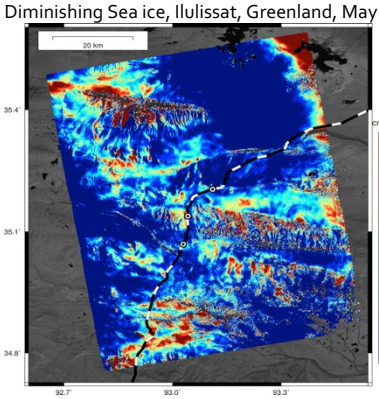
Project: Students select their preferred remote sensing sensors for scientific (physical, social or public health) or engineering applications.

Diminishing Sea ice, Ilulissat, Greenland, May 2013

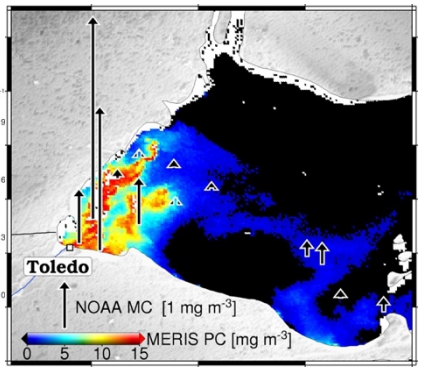
Issyk-kul endorheic Lake, Kyrgyzstan, facing Tien Shan



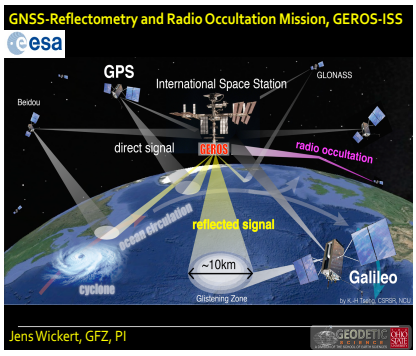
Altimetry dynamic topography (CNES)



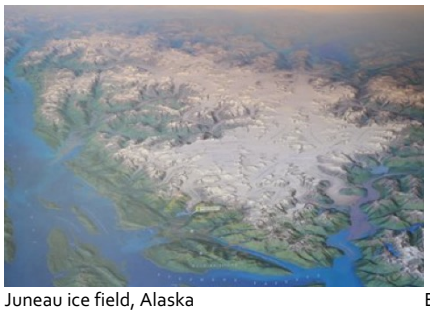
Tibet permafrost degradation from ALOS InSAR



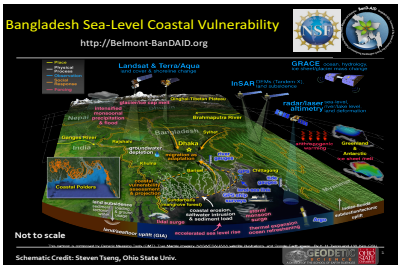
Western Lake Erie harmful algae bloom sensing



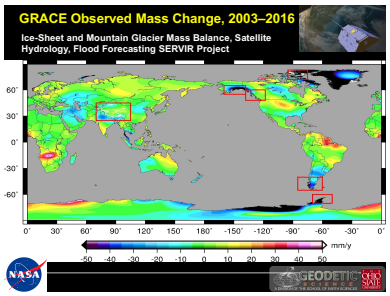
GNSS Reflectometry on International Space Station



Juneau ice field, Alaska



Bangladesh delta coastal vulnerability



GRACE observed Earth mass transports

GPS monitoring of solid Earth deformation, Ilulissat, Greenland, May 2013

GEODETIC SCIENCE
A DIVISION OF THE SCHOOL OF EARTH SCIENCES
THE OHIO STATE UNIVERSITY
SCHOOL OF EARTH SCIENCES

Autumn 2018

SCHOOL OF EARTH SCIENCES, OHIO STATE UNIVERSITY

B.S. PROGRAM

AUTUMN 2018

Overview

The B.S. program in Earth Sciences is the course of study taken by our undergraduates who plan to pursue a career in the Earth Sciences, either by continuing to graduate school in the sciences or by entering the Earth Science workforce immediately after graduation. Over the last 30 years, more than 90% of our undergraduates have earned the B.S., and we anticipate that the majority of our future students will continue to pursue the B.S. degree. As a result, our B.S. program must be designed to prepare students across the broad range of subdisciplines that are incorporated in the modern and expanding field of Earth Sciences. Four subprograms were established during semester conversion, to provide this range of coverage; each subprogram includes courses that introduce the broad range of the Earth Sciences, but each subprogram also requires several courses that develop a depth of knowledge and understanding within its area of concentration.

Establishment of the 4 subprograms within our B.S. program coincided with an ~300% increase in the number of our B.S. majors, so that we presently have ~150 B.S. majors.

LIST OF PROGRAM REQUIREMENTS

1) GEOLOGICAL SCIENCES subprogram:

A) PREPARATION FOR THE MAJOR

Semester course number	Semester course name	Semester credit hours
Chem 1210	General Chemistry 1	5
Math 1151	Calculus 1	5
Math 1152	Calculus 2	5
Bio 1113	Energy Transfer and Development	4
Physics 1250	Physics 1	5
EARTHSC 1121	The Dynamic Earth	4
EARTHSC 1122	Earth through Time	4
EARTHSC 2245	Introductory Data Analysis for Earth and Environmental Sciences	4
Complete either Chem 1220 or Physics 1251		5
Minimum of 2 additional courses in sciences and mathematics, chosen from: Chem 1220 and above Math 2153 and above Physics 1251 and above EEOB 3310 (Evolution) Geog 5900 (Climatology) Geog 5200 (Cartography) Other options require approval by an SES advisor.		10
Total semester hours in Preparation for the major		51
Note: Where available, an Honors offering can be substituted for the equivalent non-Honors course listed in the Preparation for the Major.		

B. MAJOR PROGRAM REQUIREMENTS

Core Requirements

Semester course number	Semester course name	Semester credit hours	Prereqs.
Complete a minimum of 31 semester credit hours, including the following requirements: **a) Complete the following courses:**			
EARTHSC 4421	Earth Materials	3	Chem 1210
EARTHSC 4423	Intro Petrology	3	EARTHSC 1121 & 4421
EARTHSC 4530	Structural Geology	4	EARTHSC 1121 & Physics 1250
EARTHSC 4999.01(H)	Undergraduate Research for Thesis in Earth Sciences	1 (graded)	Rank 4 in EARTHSC & permission of instructor
EARTHSC 5189.01	Field Geology 1	3	EARTHSC 4423 & 4530 & permission of instructor
EARTHSC 5189.02	Field Geology 2	3	EARTHSC 5189.02
EARTHSC 4501	Paleontology	4	EARTHSC 1122 & 3 cr hrs in bio sciences
EARTHSC 4502	Stratigraphy and Sedimentology	4	EARTHSC 1121 & 1122

Additional Requirements

b) Complete at least 2 courses (minimum of 6 semester credit hours) from EARTHSC courses at the 5000-level or above (except EARTHSC 5189.03, 5189.04, 5189.05, 5189.06, 5580, and 5584), OR Complete at least 1 course (minimum of 3 semester credit hours) from EARTHSC courses at the 5000-level or above (except EARTHSC 5189.03, 5189.04, 5189.05, 5189.06, 5580, and 5584), and GEOSCIM 5781:		
EARTHSC upper-level electives (Note: EARTHSC 5189.03, 5189.04, 5189.05, 5189.06, 5580, and 5584 cannot be used to meet this requirement)	6	Varies by course
TOTAL SEMESTER CREDIT HOURS	31	

SEMESTER ADVISING SHEET

STUDENT NAME: _____ ID _____

EARTH SCIENCES B.S. – GEOLOGICAL SCIENCES SUBPROGRAM

	Semester (Au, Sp, Su)	Year	Credits	Grade

I) PREPARATION FOR THE MAJOR:

a) Complete the following courses:

EARTHSC 1121:	_____	_____	____4____	_____
EARTHSC 1122:	_____	_____	____4____	_____
EARTHSC 2245:	_____	_____	____4____	_____
Biology 1113:	_____	_____	____4____	_____
Chemistry 1210:	_____	_____	____5____	_____
Physics 1250:	_____	_____	____5____	_____
Math 1151:	_____	_____	____5____	_____
Math 1152:	_____	_____	____5____	_____

b) Complete either Chemistry 1220 or Physics 1251:

Chemistry 1220 or Physics 1251	_____	_____	____5____	_____

c) Complete a minimum of 2 additional courses in the sciences and mathematics, chosen from Chem 1220 (if not used to satisfy Requirement "b") and above; Math 2153 and above; Physics 1251 (if not used to satisfy Requirement "b") and above; EEOB 3310; Geog 5900 and 5200. Other options require approval by an SES advisor.

_____:	_____	_____	_____	_____
_____:	_____	_____	_____	_____

Note: Where available, an Honors offering can be substituted for the equivalent non-Honors course listed in the Preparation for the Major.

II) MAJOR PROGRAM REQUIREMENTS:

Complete a minimum of 31 semester credit hours, including the following requirements:

a) Complete the following courses:

EARTHSC 4421:	_____	_____	_____3_____	_____
EARTHSC 4423:	_____	_____	_____3_____	_____
EARTHSC:4501:	_____	_____	_____4_____	_____
EARTHSC 4502:	_____	_____	_____4_____	_____
EARTHSC 4530:	_____	_____	_____4_____	_____
EARTHSC 5189.01:	_____	_____	_____3_____	_____
EARTHSC 5189.02:	_____	_____	_____3_____	_____
EARTHSC 4999.01(H):	_____	_____	_____1_____	_____

b) Complete at least 2 additional courses (6 credits minimum) in Earth Sciences at the 5000-level or above: (Note: EARTHSC 5189.03, 5189.04, 5189.05, 5189.06, 5580, and 5584 cannot be used to meet this requirement)
OR
Complete at least 1 additional course (3 credits minimum) in Earth Sciences at the 5000-level or above (Note: EARTHSC 5189.03, 5189.04, 5189.05, 5189.06, 5580, and 5584 cannot be used to meet this requirement), and GEOSCIM 5781

EARTHSC _____:	_____	_____	_____	_____
EARTHSC _____ Or GEOSCIM 5781:	_____	_____	_____	_____

Example 4 year plan

Yr 1	Autumn	Spring		
GE language	4 cr.	GE language	4 cr.	
Math 1151(GE)	5 cr.	Math 1152	5 cr.	
Chem 1210	5 cr.	Chem 1220	5 cr.	
ASC Survey	1 cr.			
Total = 15 cr.		Total = 14 cr.		
Yr 2	Autumn	Spring		
GE language	4 cr.	EARTHSC prep 1	3 cr.	
Bio 1113 (GE)	4 cr.	GE elective	3 cr.	
EARTHSC 1121 (GE)	4 cr.	EARTHSC 1122 (GE)	4 cr.	
Physics 1250	5 cr.	EARTHSC 2245 (GE)	4 cr.	
Total = 17 cr.		Total = 14 cr.		
Yr 3	Autumn	Spring		Summer
GE elective	3 cr.	GE elective	3 cr.	EARTHSC 5189.01 3 cr.
GE elective	3 cr.	GE elective	3 cr.	EARTHSC 5189.02 3 cr.
EARTHSC 4421 (7 weeks)	3 cr.	EARTHSC 4501	4 cr.	(Note: courses only offered
EARTHSC 4423 (7 weeks)	3 cr.	EARTHSC 4530	4 cr.	in summer in Utah)
EARTHSC prep 2	3 cr.			
Total = 15 cr		Total = 14 cr.		Total = 6 cr.
Yr 4	Autumn	Spring		
GE elective	3 cr.	EARTHSC elective 2	3 cr.	
GE elective	3 cr.	EARTHSC 4999.01(H)	1 cr.	
EARTHSC 4502	4 cr.	GE elective	3 cr.	
EARTHSC elective 1	3 cr.	GE elective	3 cr.	
		GE elective	3 cr.	
Total = 13 cr.		Total = 13 cr.		

Total = 121 semester credits, with all semester-version GE requirements met and 31 semester credits of upper-level Earth Science coursework to meet requirements of the major.

2) EARTH SYSTEM SCIENCE subprogram:

A) PREPARATION FOR THE MAJOR

Semester course number	Semester course name	Semester credit hours
Chem 1210	General Chemistry 1	5
Math 1151	Calculus 1	5
Math 1152	Calculus 2	5
Bio 1113	Energy Transfer and Development	4
Physics 1250	Physics 1	5
EARTHSC 1121	The Dynamic Earth	4
EARTHSC 1122	Earth through Time	4
EARTHSC 2245	Introductory Data Analysis for Earth and Environmental Sciences	4
Complete either Chem 1220 or Physics 1251		5
Minimum of 2 additional courses in sciences and mathematics, chosen from: Chem 1220 and above Math 2153 and above Physics 1251 and above EEOB 3310 (Evolution) Geog 5900 (Climatology) Geog 5200 (Cartography) Other options require approval by an SES advisor.		10
Total semester hours in Preparation for the major		51
Note: Where available, an Honors offering can be substituted for the equivalent non-Honors course listed in the Preparation for the Major.		

B. MAJOR PROGRAM REQUIREMENTS

Core Requirements

Semester course number	Semester course name	Semester credit hours	Prereqs.
Complete a minimum of 30 semester credit hours, including the following requirements: **a.1) Complete 4 of the following courses, with at least 2 being courses with labs:**			
EARTHSC 4450	Water, Ice and Energy in the Earth System	3	EARTHSC 1100 or 1121 or Geog 3901 or 3900 or 5900; or permission of instructor
EARTHSC 4502	Stratigraphy and Sedimentology (with lab)	4	EARTHSC 1121 & 1122
EARTHSC 5206	Advanced Oceanography	3	EARTHSC 1100 or 1105 or 1121 or graduate standing or permission of instructor
EARTHSC 5550	Geomorphology (with lab)	4	EARTHSC 1121; EARTHSC 1122; or permission of instructor
EARTHSC 5621	Introduction to Geochemistry	3	Rank 4 standing in EARTHSC or related field; Chem 1220 or above or permission of instructor
EARTHSC 5651	Hydrogeology (with lab)	4	EARTHSC 1121 and Math 1152 or above
EARTHSC 5655	Land Surface Hydrology	3	Math 1152 or above, Chem 1210 or above, and Physics 1250 or above
a.2) Complete the following course:			

EARTHSC 4999.01(H)	Undergraduate Research for Thesis in Earth Sciences	1 (graded)	Rank 4 standing in EARTHSC & permission of instructor

Additional Requirements

b) Complete each of the following 3 requirements:			
1) Complete at least 3 semester credits of Internship, Research, and/or Field Experience from one or a combination of the following:		3	
EARTHSC 5191	Internship in the Earth Sciences		EARTHSC 5191: Rank 3 or above & permission of instructor
EARTHSC 4998(H) or 4999.02(H)	Undergraduate Research in the Earth Sciences OR Undergraduate Research for Thesis in the Earth Sciences		EARTHSC 4998(H)/4999.02(H): Permission of instructor (and Honors Program for 4998H and 4999.02H)
EARTHSC 5XXX	An approved field course (e.g., EARTHSC 5602.02, 5670, 5189.01)		Field course: Varies; minimum is EARTHSC 1100 or 1121
2) Complete at least 2 EARTHSC courses (minimum of 6 semester credits) at the 4000-level or above, or at least 1 EARTHSC course at the 4000-level or above (minimum of 3 semester credits) and GEOSCIM 5781 **(Note: EARTHSC 5580, 5584, and 5189.03, 5189.04, 5189.05, 5189.06 cannot be used to**		6	Varies

satisfy B.S. requirements)		

Additional Requirements

3) Complete at least 2 courses (minimum of 6 semester credits) from outside Earth Sciences, chosen from the following: (Other courses require approval by an Earth Sciences advisor)		6	
Geog 3900	Global Climate Change: Causes and Consequences	3	
Geog 3901	Global Climate and Environmental Change	3	
Geog 3980	Biogeography: An Introduction to Life on Earth	3	
Geog 5900 (if not used to satisfy Preparation of the Major)	Climatology	3	
Geog 5801	Environmental Conservation	3	
Geog 5802	Globalization and Environment	3	

Geog 5220	Fundamentals of Geographic Information Systems	3	
Geog 5223	Design and Implementation of GIS	3	Geog 5220
ATMOSSC 2940	Basic Meteorology	3	Math 1151 and Physics 1250
EEOB 4950	Field Ecology	2	Rank 3 standing or above; 12 semester hours of biological sciences or permission of instructor
EEOB 3310	Evolution	4	Bio 1114 or 1114H
EEOB 5420	Aquatic Ecosystems: Ecology of Inland Waters	1.5	EEOB 3410
EEOB 3410	Ecology	4	Bio 1114 or 1114H
AEDECON 2001	Principles of Food and Resource Economics	3	
AEDECON 4310	Environmental and Natural Resource Economics	3	AEDE 2001 or Econ 2001
AEDECON 4320/ INTSTDS 4320	Energy, the Environment, and the Economy	3	AEDE 2001 or Econ 2001
ENVENG 3200	Fundamentals of Environmental Engineering	3	Chem 1210

ENVENG 2100	Environmental Engineering Analytical Methods	3	Chem 1210 and 1220
CIVILEN 5001	Fundamentals of Geographic Information Systems	4	CE 2050 or written permission of instructor.
ENR 3000	Soil Science	3	
ENR 3280	Water Quality Management	2	
ENR 4260	Soil Resource Management	3	ENR 3000 or permission of instructor
ENR 2367	Communicating Contemporary Environmental and Natural Resource Issues	3	
INTSTDS 4800	Cultural Diplomacy	3	Rank 2 or above, or permission of instructor
CHEM 2210 or 2210H	Analytical Chemistry 1: Quantitative Analysis	5	Chem 1220 and Math 1151

SEMESTER ADVISING SHEET

STUDENT NAME: _____ ID _____

EARTH SCIENCES B.S. –EARTH SYSTEM SCIENCE SUBPROGRAM

	Semester (Au, Sp, Su)	Year	Credits	Grade

I) PREPARATION FOR THE MAJOR:

a) Complete the following courses:

EARTHSC 1121:	_____	_____	____4___	_____
EARTHSC 1122:	_____	_____	____4___	_____
EARTHSC 2245:	_____	_____	____4___	_____
Biology 1113:	_____	_____	____4___	_____
Chemistry 1210:	_____	_____	____5___	_____
Physics 1250:	_____	_____	____5___	_____
Math 1151:	_____	_____	____5___	_____
Math 1152:	_____	_____	____5___	_____

b) Complete either Chemistry 1220 or Physics 1251:

Chemistry 1220 or Physics 1251	_____	_____	____5___	_____

c**) Complete a minimum of 2 additional courses in the sciences and mathematics, chosen from Chem 1220 (If not used to satisfy Requirement "b") and above; Math 2153 and above; Physics 1251 (if not used to satisfy Requirement "b") and above; EEOB 3310; Geog 5900 and 5200. Other options require approval by an SES advisor**.

_____:	_____	_____	_____	_____
_____:	_____	_____	_____	_____

Note: Where available, an Honors offering can be substituted for the equivalent non-Honors course listed in the Preparation for the Major.

II) MAJOR PROGRAM REQUIREMENTS:

Complete a minimum of 30 semester credit hours, including the following requirements:

a.1) Complete 4 of the following courses, including at least 2 of EARTHSC 4502, 5550, and 5651:

EARTHSC 4450:	_____	_____	_____3_____	_____
EARTHSC 4502:	_____	_____	_____4_____	_____
EARTHSC 5206:	_____	_____	_____3_____	_____
EARTHSC 5550:	_____	_____	_____4_____	_____
EARTHSC 5621:	_____	_____	_____3_____	_____
EARTHSC 5651:	_____	_____	_____4_____	_____
EARTHSC 5655:	_____	_____	_____3_____	_____

a.2) Complete the following course

EARTHSC 4999.01(H):	_____	_____	_____1_____	_____

b) Complete at least 3 credits from EARTHSC 5191 (Internship), EARTHSC 4998(H) or 4999.02(H), or an approved field course (a combination of courses is acceptable):

EARTHSC _____:	_____	_____	_____	_____
EARTHSC _____:	_____	_____	_____	_____

c) Complete at least 2 additional courses (6 credits minimum) in Earth Sciences at the 4000-level or above. (Note: EARTHSC 5580, 5584, and 5189.03, 5189.04, 5189.05, 5189.06 cannot be used to satisfy B.S. requirements)
OR
Complete at least 1 additional course (3 credits minimum) in Earth Sciences at the 4000-level or above (note: EARTHSC 5580, 5584, and 5189.03, 5189.04, 5189.05, 5189.06 cannot be used to satisfy B.S. requirements) and GEOSCIM 5781

EARTHSC _____:	_____	_____	_____	_____
EARTHSC _____:				
Or GEOSCIM 5781	_____	_____	_____	_____

d) Complete at least 2 additional courses (6 credits minimum) from outside Earth Sciences, chosen from Geog 3900, Geog 3901, Geog 3980, Geog 5900 (if not used to satisfy Preparation for the Major), Geog 5801, Geog 5802, Geog 5220, Geog 5223, ATMOSSC 2940, EEOB 4950, EEOB 3310, EEOB 5420, EEOB 3410, AEDECON 2001, AEDECON 4310, AEDECON 4320, ENVENG 3200, ENVENG 2100, CIVILEN 5001, ENR 3000, ENR 3280, ENR 4260, ENR 2367, INTSTDS 4800, INTSTDS 4320, Chem 2110 (other courses require approval by an Earth Sciences advisor):

_____: _____ _____ _____ _____

_____: _____ _____ _____ _____

Example 4 year plan

Yr 1	Autumn	Spring
GE language	4 cr.	GE language 4 cr.
Math 1151(GE)	5 cr.	Math 1152 5 cr.
Chem 1210	5 cr.	Chem 1220 5 cr.
ASC Survey	1 cr.	
Total = 15 cr.		Total = 14 cr.
Yr 2	Autumn	Spring
GE language	4 cr.	EARTHSC prep 1 3 cr.
Bio 1113 (GE)	4 cr.	GE elective 3 cr.
EARTHSC 1121 (GE)	4 cr.	EARTHSC 1122 (GE) 4 cr.
Physics 1250	5 cr.	EARTHSC 2245 (GE) 4 cr.
Total = 17 cr.		Total = 14 cr.
Yr 3	Autumn	Spring
GE elective	3 cr.	GE elective 3 cr.
GE elective	3 cr.	GE elective 3 cr.
EARTHSC 4450	3 cr.	EARTHSC 5206 3 cr.
EARTHSC 4502	4 cr.	EARTHSC elective 1 3 cr.
EARTHSC prep 2	3 cr.	Non-EARTHSC elective 1 3 cr.
Total = 16 cr		Total = 15 cr.
Yr 4	Autumn	Spring
GE elective	3 cr.	Non-EARTHSC elective 2 3 cr.
GE elective	3 cr.	EARTHSC 4999.01(H) 1 cr.
EARTHSC 5651	4 cr.	GE elective 3 cr.
EARTHSC elective 2	3 cr.	GE elective 3 cr.
Research or Internship	3 cr.	GE elective 3 cr.
		Free elective 1 cr.
Total = 16 cr.		Total = 14 cr.

Total = 121 semester credits, with all semester-version GE requirements met and 30 semester credits of coursework in Earth Sciences and other approved areas to meet requirements of the major.

3) GEOPHYSICS subprogram:

A) PREPARATION FOR THE MAJOR

Semester course number	Semester course name	Semester credit hours
Chem 1210	General Chemistry 1	5
Math 1151	Calculus 1	5
Math 1152	Calculus 2	5
Bio 1113	Energy Transfer and Development	4
Physics 1250	Physics 1	5
EARTHSC 1121	The Dynamic Earth	4
EARTHSC 1122	Earth through Time	4
EARTHSC 2245	Introductory Data Analysis for Earth and Environmental Sciences	4
Physics 1251	Physics 2	5
Minimum of 2 additional courses in sciences and mathematics, chosen from: Chem 1220 and above Math 2153 and above Physics above 1251 EEOB 3310 (Evolution) Geog 5900 (Climatology) Geog 5200 (Cartography) Other options require approval by an SES advisor.		10
Total semester hours in Preparation for the major		51
Note: Where available, an Honors offering can be substituted for the equivalent non-Honors course listed in the Preparation for the Major		

B. MAJOR PROGRAM REQUIREMENTS

Core Requirements

Course number	Course Name	Credit Hrs	Prerequisites

Complete a minimum of 31 credit hours in Earth Sciences, including the following requirements:

(a) Complete the following courses (7 credit hours):

EARTHSC 4221	Earth Materials	3	Chem 1210
EARTHSC 4423	Intro Petrology	3	EARTHSC 1121 & 4421
EARTHSC 4999.01(H)	Undergraduate Research for Thesis in Earth Sciences	1 (graded)	Permission of instructor (Honors Program for 4999.01H)

(b) Complete two of the following solid earth geophysics/geomathematics courses (6 credit hours):

EARTHSC 5641	Geostatistics	3	Stat 5301 and Math 1152 or above, or permission of instructor
EARTHSC 5642	Geomathematical Analysis	3	Math 1152 or above, or permission of instructor
EARTHSC 5646	Geodynamics	3	Math 1152, Physics 1250 & EARTHSC 4530, or permission of instructor
EARTHSC 5680	Deep Earth Geophysics	3	Math 1152 and Physics 1251
GEOSCIM 5781	Geodesy & Geodynamics	3	Math 1152 or above, or Physics 1251, or permission of instructor

(c) Complete two of these applied geophysics courses (6 or 7 credit hours):

EARTHSC ~~4310~~5310	Remote Sensing in the Earth Sciences	3	EARTHSC 1121; Physics 1250; Math 1151 or above

EARTHSC 4560	Applied Geophysics	3	EARTHSC 1121, Math 1151 & Physics 1250
EARTHSC 5687	Energy Geophysics	3	EARTHSC 1121; Math 1151; Physics 1250
EARTHSC 5751	Quantitative Reservoir Modeling	4	EARTHSC 2245 & Math 1152, or permission of instructor
EARTHSC 5780	Reflection Seismology	4	EARTHSC 1121; Math 1151; Physics 1250
EARTHSC 5781	Gravity Exploration	3	Math 1152 or above, grad standing or permission of instructor
EARTHSC 5782	Magnetic Exploration	3	Math 1152 or above, grad standing or permission of instructor

Additional Requirements

(d) Complete at least 11 semester hours from the courses listed below

EARTHSC 54310 (if not used to meet requirement "c")	Remote Sensing in the Earth Sciences	3	EARTHSC 1121; Physics 1250; Math 1151
EARTHSC 4450	Water, Ice, and Energy in the Earth System	3	EARTHSC 1121, and Chem 1210 or Physics 1250, or permission of instructor
EARTHSC 4501	Paleontology	4	EARTHSC 1122 and 3 cr hrs in biological sciences.
EARTHSC 4502	Stratigraphy and Sedimentation	4	EARTHSC 1121; EARTHSC 1122
EARTHSC 4530	Structural Geology	4	EARTHSC 1121; Physics 1250 or above
EARTHSC 4560 (if not used to meet	Applied Geophysics	3	EARTHSC 1121, Math 1151 &

requirement “c”)			Physics 1250
EARTHSC 4998(H) (Maximum of 3 credit hours of 4998(H) + 4999.02(H) + 5191 allowed)	Research	1-3	permission of instructor (Honors Program for 4998H)
EARTHSC 4999.02(H) (Maximum of 3 credit hours of 4998(H) + 4999.02(H) + 5191 allowed)	Research for Thesis	1-3	permission of instructor (Honors Program for 4999.02(H)
EARTHSC 5189.01	Field Geology I	3	EARTHSC 4423; EARTHSC 4530; and permission of instructor.
EARTHSC 5189.02	Field Geology II	3	EARTHSC 5189.01
EARTHSC 5191 (Maximum of 3 credit hours of 4998(H) + 4999.02(H) + 5191 allowed)	Internship	1-3	permission of instructor
EARTHSC 5206	Advanced Oceanography	3	EARTHSC 1100 or EARTHSC 1105 or EARTHSC 1121 or graduate student standing or permission of instructor
EARTHSC 5550	Geomorphology	4	EARTHSC 1121; EARTHSC 1122; or permission of instructor
EARTHSC 5621	Introduction to Geochemistry	3	Sr in EARTHSC or related fields; Chem 1220 or above, or permission of instructor
EARTHSC 5629	Principles of Petrology	3	Sr or Grad standing in EARTHSC or related fields, or permission of instructor

EARTHSC 5641 (if not used to meet requirement “b”)	Geostatistics	3	Stat 5301 and Math 1152 or above, or permission of instructor
EARTHSC 5642 (if not used to meet requirement “b”)	Geomathematical Analysis	3	Math 1152 or above, or permission of instructor
EARTHSC 5646 (if not used to meet requirement “b”)	Geodynamics	3	Math 1152 and Physics 1250 & EARTHSC 4530, or permission of instructor
EARTHSC 5650	Glaciology	3	EARTHSC 4450 or permission of instructor
EARTHSC 5651	Hydrogeology	4	EARTHSC 1121; Math 1152 or above
EARTHSC 5655	Land Surface Hydrology	3	Math 1152 or above, Chem 1210 or above, and Physics 1250 or above
EARTHSC 5661	Petroleum Geology	4	EARTHSC 4423 & 4502; or written permission of instructor
EARTHSC 5680 (if not used to meet requirement “b”)	Deep Earth Geophysics	3	Math 1152 and Physics 1251
EARTHSC 5687 (if not used to meet requirement “c”)	Energy Geophysics	3	EARTHSC 1121; Math 1151; Physics 1250
EARTHSC 5751 (if not used to meet requirement “c”)	Quantitative Reservoir Modeling	4	EARTHSC 2245 & Math 1152, or permission of instructor
EARTHSC 5780 (if not used to meet requirement “c”)	Reflection Seismology	4	EARTHSC 1121; Math 1151; Physics 1250
EARTHSC 5781 (if not used to meet requirement “c”)	Gravity Exploration	3	Math 1152 or above, grad standing or permission of

			instructor
EARTHSC 5782 (if not used to meet requirement “c”)	Magnetic Exploration	3	Math 1152 or above, grad standing or permission of instructor
GEOSCIM 5781 (if not used to meet requirement “b”)	Geodesy & Geodynamics	3	Math 1152 or above, or Physics 1251, or permission of instructor

SEMESTER ADVISING SHEET

STUDENT NAME: _____ ID _____

EARTH SCIENCES B.S. –GEOPHYSICS SUBPROGRAM

	Semester (Au, Sp, Su)	Year	Credits	Grade

I) PREPARATION FOR THE MAJOR:

a) Complete the following courses:

EarthSci 1121:	_____	_____	____4___	_____
EarthSci 1122:	_____	_____	____4___	_____
EarthSci 2245:	_____	_____	____4___	_____
Biology 1113:	_____	_____	____4___	_____
Chemistry 1210:	_____	_____	____5___	_____
Physics 1250:	_____	_____	____5___	_____
Math 1151:	_____	_____	____5___	_____
Math 1152:	_____	_____	____5___	_____

b) Complete Physics 1251:

Physics 1251:	_____	_____	____5___	_____

c**) Complete a minimum of 2 additional courses in the sciences and mathematics, chosen from Chem 1220 and above; Math 2153 and above; Physics above 1251; EEOB 3310; Geog 5900 and 5200. Other options require approval by an SES advisor**.

_____:	_____	_____	_____	_____
_____:	_____	_____	_____	_____

Note: Where available, an Honors offering can be substituted for the equivalent non-Honors course listed in the Preparation for the Major.

II) MAJOR PROGRAM REQUIREMENTS:

Complete a minimum of 31 semester credit hours in Earth Sciences, including the following requirements:

a) Complete the following courses (7 credit hours):

EarthSci 4421:	_____	_____	3	_____
EarthSci 4423:	_____	_____	3	_____
EarthSci 4999.01(H)	_____	_____	1	_____

b) Complete 2 of the following courses (6 credit hours):

EarthSci 5641:	_____	_____	3	_____
EarthSci 5642:	_____	_____	3	_____
EarthSci 5646:	_____	_____	3	_____
EarthSci 5680:	_____	_____	3	_____
GEOSCIM 5781:	_____	_____	3	_____

c) Complete 2 of the following courses (6 or 7 credit hours):

EarthSci 54310:	_____	_____	3	_____
EarthSci 4560:	_____	_____	3	_____
EarthSci 5687:	_____	_____	3	_____
EarthSci 5751:	_____	_____	4	_____
EarthSci 5780:	_____	_____	4	_____
EarthSci 5781:	_____	_____	3	_____
EarthSci 5782:	_____	_____	3	_____

d) Complete at least 11 additional credit hours, chosen from the following courses:

EARTHSC 54310 (if not used to meet Requirement "b"), EARTHSC 4450, EARTHSC 4501, EARTHSC 4502, EARTHSC 4530, EARTHSC 4560 (if not used to meet Requirement "c"), EARTHSC 4998(H) (maximum of 3 credit hours of 4998(H) + 4999.02(H) + 5191 allowed), EARTHSC 4999.02(H) (maximum of 3 credit hours of 4998(H) + 4999.02(H) + 5191 allowed), EARTHSC 5189.01, EARTHSC 5189.02, EARTHSC 5191 (maximum of 3 credit hours of 4998(H) + 4999.02(H) + 5191 allowed), EARTHSC 5206, EARTHSC 5550, EARTHSC 5621, EARTHSC 5629, EARTHSC 5641 (if not used to meet Requirement "b"), EARTHSC

5642 (if not used to meet Requirement “b”), EARTHSC 5646 (if not used to meet Requirement “b”), EARTHSC 5650, EARTHSC 5651, EARTHSC 5655, EARTHSC 5661, EARTHSC 5680 (if not used to meet Requirement “b”), EARTHSC 5687 (if not used to meet Requirement “c”), EARTHSC 5751 (if not used to meet Requirement “c”), EARTHSC 5780 (if not used to meet Requirement “c”), EARTHSC 5781 (if not used to meet Requirement “c”), EARTHSC 5782 (if not used to meet Requirement “c”), GEOSCIM 5781 (if not used to meet Requirement “b”)

EarthSci _____:	_____	_____	_____	_____
EarthSci _____:	_____	_____	_____	_____
EarthSci _____:	_____	_____	_____	_____
EarthSci _____: Or GEOSCIM 5781	_____	_____	_____	_____

Example 4 year plan

Yr 1	Autumn	Spring
GE language	4 cr.	GE language 4 cr.
Math 1151(GE)	5 cr.	Math 1152 5 cr.
Chem 1210	5 cr.	Physics 1250 5 cr.
ASC Survey	1 cr.	.
Total = 15 cr.		Total = 14 cr.
Yr 2	Autumn	Spring
GE language	4 cr.	EARTHSC prep 1 3 cr.
Bio 1113 (GE)	4 cr.	GE elective 3 cr.
EARTHSC 1121 (GE)	4 cr.	EARTHSC 1122 (GE) 4 cr.
Physics 1251	5 cr.	EARTHSC 2245 (GE) 4 cr.
Total = 17 cr.		Total = 14 cr.
Yr 3	Autumn	Spring
GE elective	3 cr.	GE elective 3 cr.
GE elective	3 cr.	GE elective 3 cr.
EARTHSC 4421 (7 weeks)	3 cr.	EARTHSC elective b-1 3 cr.
EARTHSC 4423 (7 weeks)	3 cr.	EARTHSC elective c-1 3 cr.
EARTHSC prep 2	3 cr.	EARTHSC elective d-1 3 cr.
Total = 15 cr		Total = 15 cr.
Yr 4	Autumn	Spring
GE elective	3 cr.	EARTHSC elective d-3 3 cr.
GE elective	3 cr.	EARTHSC elective d-4 3 cr.
EARTHSC elective b-2	3 cr.	GE elective 3 cr.
EARTHSC elective c-2	3 cr.	GE elective 3 cr.
EARTHSC elective d-2	3 cr.	GE elective 3 cr.
.		EARTHSC 4999.01(H) 1 cr
Total = 15 cr.		Total = 16 cr.

Total = 121 semester credits, with all semester-version GE requirements met and 31 semester credits of upper-level Earth Science coursework to meet requirements of the major.

4) PETROLEUM GEOLOGY & GEOPHYSICS subprogram:

A) PREPARATION FOR THE MAJOR

Semester course number	Semester course name	Semester credit hours
Chem 1210	General Chemistry 1	5
Math 1151	Calculus 1	5
Math 1152	Calculus 2	5
Bio 1113	Energy Transfer and Development	4
Physics 1250	Physics 1	5
EARTHSC 1121	The Dynamic Earth	4
EARTHSC 1122	Earth through Time	4
EARTHSC 2245	Introductory Data Analysis for Earth and Environmental Sciences	4
Complete either Chem 1220 or Physics 1251		5
Minimum of 2 additional courses in sciences and mathematics, chosen from: Chem 1220 and above Math 2153 and above Physics 1251 and above EEOB 3310 (Evolution) Geog 5900 (Climatology) Geog 5200 (Cartography) Other options require approval by an SES advisor.		10
Total semester hours in Preparation for the major		51
Note: Where available, an Honors offering can be substituted for the equivalent non-Honors course listed in the Preparation for the Major		

B. MAJOR PROGRAM REQUIREMENTS

REVISED PROGRAM REQUIREMENTS

Core Requirements

Semester course number	Semester course name	Semester credit hours	Prereqs.
Complete a minimum of 31 semester credit hours in Earth Sciences, including the following requirements: **a) Complete the following courses (19 semester credit hours):**			
EARTHSC 4421	Earth Materials	3	Chem 1210
EARTHSC 4423	Intro Petrology	3	EARTHSC 1121 & 4421
EARTHSC 4502	Stratigraphy and Sedimentology	4	EARTHSC 1121 & 1122
EARTHSC 4530	Structural Geology	4	EARTHSC 1121 & Physics 1250
EARTHSC 5661	Petroleum Geology	4	EARTHSC 4423 & 4502; or written permission of instructor
EARTHSC 4999.01(H)	Undergraduate Research for Thesis in Earth Sciences	1 (graded)	Permission of instructor (Honors Program for 4999.01H)
b) Complete 1 of the following courses (3-4 semester credit hours):			
EARTHSC 5687	Energy Geophysics	3	EARTHSC 1121; Math 1151; Physics 1250
EARTHSC 5780	Reflection Seismology	4	EARTHSC 1121; Math 1151; Physics 1250

Additional Requirements

c) Complete EARTHSC 5189.01, EARTHSC 5189.02, and at least 1 other course in List A (below), OR Complete at least 3 courses from List A. (minimum of 9 semester credit hours)			
EARTHSC 5189.01	Field Geology 1	3	EARTHSC 4423 & 4530 & permission of instructor
EARTHSC 5189.02	Field Geology 2	3	EARTHSC 5189.02
LIST A (electives)			
EARTHSC 54310	Remote Sensing in the Earth Sciences	3	EARTHSC 1121; Physics 1250 or above; Math 1151 or above.
EARTHSC 4450	Water, Ice and Energy in the Earth System	3	EARTHSC 1100 or 1121 or Geog 3901 or 3900 or 5900; or permission of instructor
EARTHSC 4501	Paleontology	4	EARTHSC 1122 and 3 cr hrs in biological sciences.
EARTHSC 4560	Applied Geophysics	3	EARTHSC 1121, Math 1151 & Physics 1250
EARTHSC 4998(H) (Maximum of 3 credit hours of 4998(H) + 4999.02(H) + 5191 allowed)	Research	1-3	Permission of instructor (Honors Program for 4998H)
EARTHSC 4999.02(H) (Maximum of 3 credit hours of 4998(H) + 4999.02(H) + 5191 allowed)	Research for Thesis in Earth Sciences	1-3	Permission of instructor (Honors Program for 4999.02H)
EARTHSC 5191 (Maximum of 3 credit hours of 4998(H) +	Internship	1-3	Permission of instructor

4999.02(H) + 5191 allowed)			
EARTHSC 5206	Advanced Oceanography	3	EARTHSC 1100 or EARTHSC 1105 or EARTHSC 1121 or graduate student standing or permission of instructor
EARTHSC 5550	Geomorphology	4	EARTHSC 1121; EARTHSC 1122; or permission of instructor
EARTHSC 5604	Sequence Stratigraphy	3	EARTHSC 4502
EARTHSC 5621	Introduction to Geochemistry	3	Sr in EARTHSC or related fields; Chem 1220 or above, or permission of instructor
EARTHSC 5641	Geostatistics	3	Stat 5301 and Math 1152 or above, or permission of instructor.
EARTHSC 5642	Geomathematical Analysis	3	Math 1152 or above, or permission of instructor.
EARTHSC 5646	Geodynamics	3	EARTHSC 4530; Math 1152 or above; Physics 1250 or above; or permission of instructor.
EARTHSC 5651	Hydrogeology	4	EARTHSC 1121; Math 1152 or above
EARTHSC 5655	Land Surface Hydrology	3	Math 1152 or above, Chem 1210 or above, and Physics 1250 or above
EARTHSC 5687 (if not used to meet Requirement “b”)	Energy Geophysics	3	EARTHSC 1121; Math 1151 or above; Physics 1250 or above.
EARTHSC 5751	Quantitative Reservoir Modeling	4	EARTHSC 2245 & Math 1152

EARTHSC 5780 (if not used to meet Requirement “b”)	Reflection Seismology	4	EARTHSC 1121; Math 1151 or above; Physics 1250 or above.
EARTHSC 5781	Gravity Exploration	3	Math 1152 or written permission of instructor
EARTHSC 5782	Magnetic Exploration	3	Math 1152 or written permission of instructor
GEOSCIM 5781	Geodesy & Geodynamics	3	Math 1152 or above, or Physics 1251, or permission of instructor
Math 2174	Linear Algebra and Differential Equations for Engineers	3	Math 2173 or permission of Math Dept.
Math 2568	Linear Algebra	3	A grade of C- or above in Math 1172, 1544, 2153, 2162.xx, 2182H, or 4182H

SEMESTER ADVISING SHEET

STUDENT NAME: _____ ID _____

EARTH SCIENCES B.S. –PETROLEUM GEOLOGY & GEOPHYSICS SUBPROGRAM

	Semester (Au, Sp, Su)	Year	Credits	Grade

I) PREPARATION FOR THE MAJOR:

a) Complete the following courses:

EarthSci 1121:	_____	_____	_____4____	_____
EarthSci 1122:	_____	_____	_____4____	_____
EarthSci 2245:	_____	_____	_____4____	_____
Biology 1113:	_____	_____	_____4____	_____
Chemistry 1210:	_____	_____	_____5____	_____
Physics 1250:	_____	_____	_____5____	_____
Math 1151:	_____	_____	_____5____	_____
Math 1152:	_____	_____	_____5____	_____

b) Complete either Chemistry 1220 or Physics 1251:

Chemistry 1220 or Physics 1251	_____	_____	_____5____	_____

c**) Complete a minimum of 2 additional courses in the sciences and mathematics, chosen from Chem 1220 (if not used to satisfy Requirement "b") and above; Math 2153 and above; Physics 1251 (if not used to satisfy Requirement "b") and above; EEOB 3310; Geog 5900 and 5200. Other options require approval by an SES advisor**.

_____:	_____	_____	_____	_____
_____:	_____	_____	_____	_____

Note: Where available, an Honors offering can be substituted for the equivalent non-Honors course listed in the Preparation for the Major.

II) MAJOR PROGRAM REQUIREMENTS:

Complete a minimum of 31 semester credit hours in Earth Sciences, including the following requirements:

a) Complete the following courses (19 credit hours):

EarthSci 4421:	_____	_____	_____3_____	_____
EarthSci 4423:	_____	_____	_____3_____	_____
EarthSci:4502:	_____	_____	_____4_____	_____
EarthSci 4530:	_____	_____	_____4_____	_____
EarthSci:5661:	_____	_____	_____4_____	_____
EarthSci 4999.01(H):	_____	_____	_____1_____	_____

b) Complete 1 of the following 2 courses (3-4 credit hours):

EarthSci 5687:	_____	_____	_____3_____	_____
EarthSci 5780:	_____	_____	_____4_____	_____

c) Complete EARTHSC 5189.01 and 5189.02 and at least 1 course from List A (minimum of 9 credit hours)
OR
Complete at least 3 courses (minimum of 9 credit hours) from List A:

EarthSci 5189.01:	_____	_____	_____3_____	_____
EarthSci 5189.02:	_____	_____	_____3_____	_____

List A: EARTHSC ~~4310~~5310, EARTHSC 4450, EARTHSC 4501, EARTHSC 4560, EARTHSC 4998(H) & 4999.02(H) & 5191 (maximum of 3 credit hours of 4998(H) + 4999.02(H) + 5191 allowed), EARTHSC 5206, EARTHSC 5550, EARTHSC 5604, EARTHSC 5621, EARTHSC 5641, EARTHSC 5642, EARTHSC 5646, EARTHSC 5651, EARTHSC 5655, EARTHSC 5687 (if not used to meet Requirement "b"), EARTHSC 5751, EARTHSC 5780 (if not used to meet Requirement "b"), , EARTHSC 5781, EARTHSC 5782, GEOSCIM 5781, Math 2174, Math 2568

EarthSci _____:	_____	_____	_____	_____
EarthSci _____:	_____	_____	_____	_____
EarthSci _____:	_____	_____	_____	_____
EarthSci _____:	_____	_____	_____	_____
_____:	_____	_____	_____	_____
_____:	_____	_____	_____	_____

Example 4 year plan

Yr 1	Autumn	Spring
GE language	4 cr.	GE language 4 cr.
Math 1151(GE)	5 cr.	Math 1152 5 cr.
Chem 1210	5 cr.	Chem 1220 5 cr.
ASC Survey	1 cr.	
Total = 15 cr.		Total = 14 cr.
Yr 2	Autumn	Spring
GE language	4 cr.	EARTHSC prep 1 3 cr.
Bio 1113 (GE)	4 cr.	GE elective 3 cr.
EARTHSC 1121 (GE)	4 cr.	EARTHSC 1122 (GE) 4 cr.
Physics 1250	5 cr.	EARTHSC 2245 (GE) 4 cr.
Total = 17 cr.		Total = 14 cr.
Yr 3	Autumn	Spring
GE elective	3 cr.	GE elective 3 cr.
GE elective	3 cr.	GE elective 3 cr.
EARTHSC 4421 (7 weeks)	3 cr.	EARTHSC 4530 4 cr.
EARTHSC 4423 (7 weeks)	3 cr.	EARTHSC elective b 3 cr.
EARTHSC prep 2	3 cr.	EARTHSC elective c-1 3 cr.
Total = 15 cr		Total = 16 cr.
Yr 4	Autumn	Spring
GE elective	3 cr.	EARTHSC elective c-3 3 cr.
GE elective	3 cr.	EARTHSC 5661 4 cr.
EARTHSC 4502	4 cr.	GE elective 3 cr.
EARTHSC elective c-2	3 cr.	GE elective 3 cr.
GE elective	3 cr.	EARTHSC 4999.01(H) 1 cr.
Total = 16 cr.		Total = 14 cr.

Total = 121 semester credits, with all semester-version GE requirements met and 31 semester credits of upper-level Earth Science coursework to meet requirements of the major.

CURRICULAR MAP OF COURSES AVAILABLE IN EARTH SCIENCES B.S.

	Course Number	Course Title	Read/ evaluate Earth Sci literature	Present Earth Sci info	Apply Earth Sci data	Apply appropriate techniques/ methods	Identify Earth Sci problems, develop solutions	Apply other sciences
Preparation for the Major								
Earth Sciences	1121	The Dynamic Earth	B	B	B	B	B	B
Earth Sciences	1122	Earth through Time	B	B	B	B	B	B
Earth Sciences	2245	Introductory Data Analysis for Earth and Environmental Sciences		B	B	B	B	B
Major Program								
Earth Sciences	4194	Group Studies	I	I	I	I	I	I
Earth Sciences	4194H	Honors Group Studies	I	I	I	I	I	I
Earth Sciences	54310	Remote Sensing in the Earth Sciences	I-A	I-A	I-A	I-A	I-A	I-A
Earth Sciences	4421	Earth Materials	I	I	I	I	I	I

	Course Number	Course Title	Read/ evaluate Earth Sci literature	Present Earth Sci info	Apply Earth Sci data	Apply appropriate techniques/ methods	Identify Earth Sci problems, develop solutions	Apply other sciences
Earth Sciences	4423	Introductory Petrology	I	I	I	I	I	I
Earth Sciences	4425	Energy Resources and Sustainability	I	I	I	I	I	I
Earth Sciences	4450	Water, Ice, and Energy in the Earth System	I	I	I	I	I	I
Earth Sciences	4501	Paleontology	I	I	I	I	I	I
Earth Sciences	4502	Stratigraphy and Sedimentation	I	I	I	I	I	I
Earth Sciences	4530	Structural Geology	I	I	I	I	I	I
Earth Sciences	4560	Applied Geophysics	I	I	I	I	I	I
Earth Sciences	4880	Seminar in Geophysics	I	I	I	I	I	I
Earth Sciences	4998	Undergraduate Research in Earth Sciences	I - A	I - A	I - A	I - A	I - A	I - A
Earth Sciences	4998H	Honors Undergraduate Research in Earth Sciences	A	A	A	A	A	A

	Course Number	Course Title	Read/ evaluate Earth Sci literature	Present Earth Sci info	Apply Earth Sci data	Apply appropriate techniques/ methods	Identify Earth Sci problems, develop solutions	Apply other sciences
Earth Sciences	4999.01	Undergraduate Thesis in Earth Sciences	A	A	A	A	A	A
Earth Sciences	4999.01 H	Honors Undergraduate Thesis in Earth Sciences	A	A	A	A	A	A
Earth Sciences	4999.02	Undergraduate Research for Thesis in Earth Sciences	I - A	I - A	I - A	I - A	I - A	I - A
Earth Sciences	4999.02 H	Honors Undergraduate Research for Thesis in Earth Sciences	I - A	I - A	I - A	I - A	I - A	I - A
Earth Sciences	5189.01	Field Geology I	I - A	I - A	I - A	I - A	I - A	I - A
Earth Sciences	5189.02	Field Geology II	I - A	I - A	I - A	I - A	I - A	I - A
Earth Sciences	5191	Internship in the Earth Sciences	I - A	I - A	I - A	I - A	I - A	I - A
Earth Sciences	5193.xx	Individual Studies	I - A	I - A	I - A	I - A	I - A	I - A
Earth Sciences	5194	Group Studies	I - A	I - A	I - A	I - A	I - A	I - A

	Course Number	Course Title	Read/ evaluate Earth Sci literature	Present Earth Sci info	Apply Earth Sci data	Apply appropriate techniques/ methods	Identify Earth Sci problems, develop solutions	Apply other sciences
Earth Sciences	5203	Geo-environment and Human Health	A	A	A	A	A	A
Earth Sciences	5206	Advanced Oceanography	A	A	A	A	A	A
Earth Sciences	5550	Geomorphology	I-A	I-A	I-A	I-A	I-A	I-A
Earth Sciences	5600	Siliciclastic Depositional Systems	A	A	A	A	A	A
Earth Sciences	5601.01	Sedimentary Petrology: Sandstones	A	A	A	A	A	A
Earth Sciences	5601.02	Sedimentary Petrology: Carbonate Rocks and Shales	A	A	A	A	A	A
Earth Sciences	5602.01	Carbonate Depositional Systems I	A	A	A	A	A	A
Earth Sciences	5602.02	Carbonate Depositional Systems II	A	A	A	A	A	A
Earth Sciences	5603	Stratigraphy	A	A	A	A	A	A
Earth Sciences	5604	Sequence Stratigraphy	A	A	A	A	A	A
Earth Sciences	5605	Paleoceano graphy	A	A	A	A	A	A

	Course Number	Course Title	Read/ evaluate Earth Sci literature	Present Earth Sci info	Apply Earth Sci data	Apply appropriate techniques/ methods	Identify Earth Sci problems, develop solutions	Apply other sciences
Earth Sciences	5613	Micropaleon tology	A	A	A	A	A	A
Earth Sciences	5614	Paleobiology	A	A	A	A	A	A
Earth Sciences	5615	Paleoecology	A	A	A	A	A	A
Earth Sciences	5617	Petrology of Earth and Planets	A	A	A	A	A	A
Earth Sciences	5618	Advanced Historical Geology	A	A	A	A	A	A
Earth Sciences	5621	Introduction to Geochemistry	A	A	A	A	A	A
Earth Sciences	5622	Stable Isotope Biogeo chemistry	A	A	A	A	A	A
Earth Sciences	5625	Igneous Petrology	A	A	A	A	A	A
Earth Sciences	5627	Global Biogeochemical Cycles	A	A	A	A	A	A
Earth Sciences	5628	Environmental Isotope Geochemistry	A	A	A	A	A	A
Earth Sciences	5629	Principles of Petrology	A	A	A	A	A	A

	Course Number	Course Title	Read/ evaluate Earth Sci literature	Present Earth Sci info	Apply Earth Sci data	Apply appropriate techniques/ methods	Identify Earth Sci problems, develop solutions	Apply other sciences
Earth Sciences	5636	Advanced Topics in Mineralogy and Crystallography	A	A	A	A	A	A
Earth Sciences	5641	Geostatistics	A	A	A	A	A	A
Earth Sciences	5642	Geomathe matical Analysis	A	A	A	A	A	A
Earth Sciences	5644	Tectonic Evolution of Continents	A	A	A	A	A	A
Earth Sciences	5645	Advanced Structural Geology	A	A	A	A	A	A
Earth Sciences	5646	Geodynamics	A	A	A	A	A	A
Earth Sciences	5650	Glaciology	A	A	A	A	A	A
Earth Sciences	5651	Hydrogeology	A	A	A	A	A	A
Earth Sciences	5655	Land Surface Hydrology	A	A	A	A	A	A
Earth Sciences	5660	Geology of Metallic Deposits	A	A	A	A	A	A
Earth Sciences	5661	Petroleum Geology	A	A	A	A	A	A

	Course Number	Course Title	Read/ evaluate Earth Sci literature	Present Earth Sci info	Apply Earth Sci data	Apply appropriate techniques/ methods	Identify Earth Sci problems, develop solutions	Apply other sciences
Earth Sciences	5663	Global Change and Sustainability in the Earth System	A	A	A	A	A	A
Earth Sciences	5670	General and Economic Geology of Selected Areas	A	A	A	A	A	A
Earth Sciences	5676	Elemental Chemical Analysis using Inductively Coupled Plasma Optical Emission and Mass Spectrometry	A	A	A	A	A	A
Earth Sciences	5680	Deep Earth Geophysics	A	A	A	A	A	A
Earth Sciences	5687	Energy Geophysics	A	A	A	A	A	A
Earth Sciences	5703	Principles of Biostratigraphy	A	A	A	A	A	A
Earth Sciences	5713	Taxonomy and Phylogeny in the Fossil Record	A	A	A	A	A	A

	Course Number	Course Title	Read/ evaluate Earth Sci literature	Present Earth Sci info	Apply Earth Sci data	Apply appropriate techniques/ methods	Identify Earth Sci problems, develop solutions	Apply other sciences
Earth Sciences	5714	Biometry	A	A	A	A	A	A
Earth Sciences	5717	Critical Issues in World Freshwater Resources	A	A	A	A	A	A
Earth Sciences	5718	Aquatic Geochemistry	A	A	A	A	A	A
Earth Sciences	5719	Environmental Organic Geochemistry	A	A	A	A	A	A
Earth Sciences	5746	Seminar in Rheological Properties of Solids	A	A	A	A	A	A
Earth Sciences	5751	Quantitative Reservoir Modeling	A	A	A	A	A	A
Earth Sciences	5752	Contaminants in Aqueous Systems	A	A	A	A	A	A
Earth Sciences	5754	Risk Assessment and Management in Earth Systems	A	A	A	A	A	A
Earth Sciences	5779	Seminar in Physical Properties of Minerals and Rocks	A	A	A	A	A	A
Earth Sciences	5780	Reflection Seismology	A	A	A	A	A	A

	Course Number	Course Title	Read/ evaluate Earth Sci literature	Present Earth Sci info	Apply Earth Sci data	Apply appropriate techniques/ methods	Identify Earth Sci problems, develop solutions	Apply other sciences
Earth Sciences	5781	Gravity Exploration	A	A	A	A	A	A
Earth Sciences	5782	Magnetic Exploration	A	A	A	A	A	A
Geod Sci	5781	Geodesy and Geodynamics	A	A	A	A	A	A
			Course Number	Course Title	Read/ evaluate Earth Sci literature	Present Earth Sci info	Apply Earth Sci data	Apply appropriate techniques/ methods
Electives from other departments (Geog, AtmosSC, EEOB, ENR, Chem, Math, etc.)								I-A

Program Learning Goals:

A) Students critically read and evaluate Earth Science literature

B) Students present Earth Science information in a clear and logical manner, both orally and in writing.

C) Students apply knowledge of Earth Science data to understand the dynamic physical, chemical, and biological processes of the Earth and its history.

D) Students apply knowledge of appropriate techniques, field methods, field mapping, and numerical methods to measure, portray, analyze, and interpret Earth Science data in specific subdisciplines.

E) Students identify Earth Science problems and develop solutions.

F) Students apply knowledge of modern applications from chemistry, physics, biology, mathematics, statistics, and computing to the solution of Earth Science problems.

Key: B = Beginning level; I = Intermediate level; A = Advanced level