Earth Science BS – Program Revision
Submitted Fall 2019. Implementation Fall 2020.

The School of Earth Sciences offers two major programs, a BS in Earth Sciences and a BA in Earth Sciences. This program revision proposal addresses the BS program only.

The School of Earth Sciences established 4 subprograms within the BS program with Ohio State's quarter-to-semester transition in 2012, Geological Sciences, Earth System Science, Geophysics, and Petroleum Geology and Geophysics. Modest revisions were made in 2014 reflecting changes to better define electives and to ensure breadth for students in the Earth System Science subprogram.

This proposal for program revision is the result of a yearlong process that occurred in 2018-2019, and included data collection from ASC graduation exit surveys and student feedback panels, survey of programs across the country including peer institutions and aspirational institutions, and a learning outcome program assessment analysis as designed by David Mogk, Department of Earth Sciences at Montana State University (see: https://serc.carleton.edu/earthandmind/posts/curriculum_desi2.html). Faculty-wide discussion of the program and proposed revisions were held October 18, January 10, January 30, April 11, and April 18. We also received feedback on draft revisions from the OAA external review team (April 1, 2019) and the Alumni and Friends Advisory Committee (April 15, 2019). A final outline of the revision was presented to the faculty and a formal vote (17-2) on May 3, 2019.

We propose a revision to the preparation for the major, as well as the tracks within the major. Central goals of the revision are to

(1) Permit students to control areas of depth and breadth of their undergraduate curriculum
(2) Offer flexibility to complete a double major by reducing preparation for the major, and in some cases aligning with complementary degree programs in other units
(3) Provide clear guidance to students on how to plan their curriculum to meet career goals
(4) Modernize course offerings and update lists of electives as offered across the University

This plan maintains those aspects of the program our program assessments, ASC exit surveys, and self-study show to be most successful: broad access to laboratory, field, and research experiences for students, as well as a capstone thesis for all students.

Below is a summary of the proposed revisions

Preparation for the major:

(1) An analysis of our existing preparation for the major identified that 2-3 classes had been required that do not serve as prerequisites for subsequent classes. We propose to remove these additional requirements.
(2) EARTHSC 1122 has been determined to be integral to the Geological Sciences track, but not the others, and it is viewed as a component of the major, not preparation. A survey of peer institutions shows that this class is

taught as a major requirement. We therefore propose updating the course, modernizing the content, adjusting its name, renumbering to 2122 to reflect increased rigor, and incorporating it as a part of the major in the geological sciences track. As the updated course content will continue to meet the requirements for the GE, we propose preserving this class's GE status.

(3) An analysis of GE data analysis requirements of other BS majors in NMS incorporate the course as part of the major instead of preparation for the major. We move EARTHSC 2245 from "preparation for the major" to part of the major itself. This helps make the major requirements more transparent to students.

(4) National data show that many Earth scientists discover their major through general education classes. A study of our general education classes shows that most of them cover the necessary prerequisite material to the classes required for the major. Some of these courses, however, do not include labs which offer the hands-on learning necessary for key preparatory learning objectives to be met.

a. To reduce barriers to pursuing the Earth Science major, we propose that all of our general education courses either serve as the disciplinary introductory course for the major (ES 1105, 1108, 1151, 2205, 2206(S)) or satisfy the Science of Sustainability requirement of the major (2203, 2210, 2155, 2122).

b. For those discovering the major through a non-lab course, we propose a 1-credit, introductory lab class (EarthSc 1200) that may be taken concurrently or subsequently to the primary 3-credit introductory course as an equivalent to EarthSc 1121 as preparation for the major.

c. All courses in the major that have previously required EarthSc 1121 for the major will be modified to permit this broader list of possible prerequisites, in which each class has been analyzed relative to the learning objectives of the general education courses and to the introductory lab class (see Table 1)

Major requirements:

(1) An analysis of student exit survey data shows a need to improve career guidance and integrate career readiness into the curriculum. Some students also struggle to complete the thesis requirement. To address this, we propose:

a. A new, 1 credit "introduction to the major" class to be taken in the first Autumn semester after declaring the major (EarthSc 2000). This course will provide a guide to career options, career readiness skills, how to find a thesis topic and advisor, as well as exposure to subdisciplines so students can identify their options within the major.

b. A "depth and breadth" requirement, in which students either complete an approved Certificate ("depth"), Minor ("depth and breadth", or any double major ("breadth"). Those students completing a certificate within the School of Earth Sciences will be able to complete their degree with as much as 11 fewer credit hours as currently, while students earning a minor with minimal additional prerequisites (e.g.

any in NMS) will complete their degree with 8-10 fewer credit hours, while those choosing one of several complementary majors will complete their degree with no additional credit hours (e.g. Biology, Environmental Science, Physics), while unrelated double majors will need to complete an increase in hours, where the number will be based on the size of the second major and preparation for that major. (See Table 2)

(2) In alignment with national trends, all students will complete a course in the Science of Sustainability.

Subprogram revisions:

(3) Our tracks are not serving the needs of our students because they need to be modernized and are not sufficiently differentiated from each other to align with the diverse career paths available in Earth Sciences. We therefore revise each subprogram to clarify their purpose to students and offer genuine choices.

a. The Geological Science subprogram undergoes the least amount of change. The largest change is that Paleontology (EarthSc 4501) is now an elective
b. We revise and rename the "Earth System Science" subprogram
    i. The revision gives the program clear disciplinary objectives.
    ii. We rename the subprogram to align with the Board of Trustees-approved division within the School of Earth Sciences, "Climate, Water, and the Environment," whose faculty will take the lead in the bulk of the instruction of this program.
c. The Geophysics subprogram is revised to ensure students have sufficient quantitative skills and fundamental physics experience to solve novel problems in geophysical fields.

(4) We will sunset the Petroleum Geology and Geophysics track, instead having these students either complete the Geological Sciences or Geophysics track and a Petroleum Geology certificate. This subprogram will be maintained for any students declaring their major before this program revision is approved.

New courses proposed as part of this Program revision

EARTHSC 1200, 1-hour Introductory lab, to ensure all students begin the major with hands-on experience with natural samples and geological processes. This course may be taking subsequently or concurrently with EARTHSC 1105, 1108, 1151, 2155, 2210, 2203, 2204, 2205, 2206, 2210, or ENR 2100

EARTHSC 2000 1-hour introduction to the major, to ensure all students begin the major with appropriate background and scope on the diversity of the earth sciences

New courses proposed as part of associated Certificate programs

EARTHSCI 5191.01 *Museum internship*, a flexible credit hour internship to be part of the Museum Certificate

EARTHSC 5501 *Museum databases*, also part of the Museum Certificate

EARTHSC/ASTRO 5205 *Planetary science* (cross listed and team taught with Astronomy) to be part of the Planetary Science certificate

Course revisions as part of this Program revision:

Renumbering and renaming of EARTHSC 1122(H) 'Historical Geology' to EARTHSC 2122(H) 'Climate and Life over Billions of years on Earth'

Broadening of prerequisites in alignment with additional courses that meet the prerequisite expectations for the course. Changes apply to the courses below, as highlighted in red.

Table 1: Courses with changes in prerequisites required to implement this plan

Course Number	Title	Existing Prerequisites	New Prerequisites	Justification
EARTHSC 1100	Planet Earth: How It Works		No credit for 1121	Similarity in content
EARTHSC 1121	The Dynamic Earth		No credit for 1100	Similarity in content
EARTHSC 4423	Intro Petrology	EARTHSC 1121 & 4421	EARTHSC 1100, 1121, OR 1200; AND 4421	Students need introductory lab
EARTHSC 4450	Water, Ice and Energy in the Earth System	EARTHSC 1100 or 1121 or Geog 3901 or 3900 or 5900; or permission of instructor	EARTHSC 1100, 1105, 1108, 1121, 1151, 2203, 2204, 2205, GEOG 3901, OR GEOG 5900; or permission of instructor	Students need prior exposure to the Earth System, broadly defined.
EARTHSC 4501	Paleontology	EARTHSC 1122 & 3 cr hrs in bio sciences	EARTHSC 1122 or 2122 & 3 cr hrs in bio sciences	Reflect numbering change
EARTHSC 4502	Stratigraphy and Sedimentology	EARTHSC 1121 & 1122	EARTHSC 1100, 1121, OR 1200; AND EARTHSC 1122 or 2122	Students need introductory lab; reflect numbering change
EARTHSC 4530	Structural Geology	EARTHSC 1121 & Physics 1250	EARTHSC 1100, 1121, OR 1200; Physics 1250	Students need introductory lab
EARTHSC 4560	Applied Geophysics	EARTHSC 1121, Math 1151 & Physics 1250	EARTHSC 1100, 1105, 1108, 1121, 1151, 2203, OR 2205, Math 1151 & Physics 1250	Students need introductory content from any of these courses
EARTHSC 5206	Advanced Oceanography	EARTHSC 1100, 1105, OR 1121; or Grad standing or permission of instructor	Junior standing or higher in any STEM major discipline; or Grad Standing; or permission of instructor	This is what marks success for students in this class
EARTHSC 5310	Remote Sensing in the Earth Sciences	EARTHSC 1121, and MATH 1141 or 1151 or above, and Physics 1250 or above; or	EARTHSC 1100, 1105, 1108, 1121, 1151, 2203, OR 2205; and MATH 1141 or	Students need introductory content from

		grad standing; or permission of instructor	1151 or above, and Physics 1250 or above; or grad standing; or permission of instructor	any of these courses
EARTHSC 5550	Geomorphology	EARTHSC 1121; EARTHSC 1122; or permission of instructor	EARTHSC 1100, 1121, OR 1200; AND EARTHSC 1122 or 2122; or permission of instructor	Students need introductory lab; reflect numbering change
EARTHSC 5651	Hydrogeology	EARTHSC 1121 and Math 1152 or above	EARTHSC 1100, 1105, 1108, 1121, 1151, 2203, OR 2205; and Math 1152 or above	Students need introductory content from any of these courses
EARTHSC 5655	Land Surface Hydrology	Math 1152 or above, Chem 1210 or above, and Physics 1250 or above.	Math 1152 or above, and Physics 1250 or above.	No chemistry required for course content
EARTHSC 5661	Petroleum Geology	EARTHSC 4423 & 4502 or 6502; or written permission of instructor	EARTHSC 4502 or 6502; or permission of instructor	Students do not need 4423 for this course.
EARTHSC 5687	Borehole Geophysics	EARTHSC 1121, Math 1141 or 1151 or above, and Physics 1250 or above	EARTHSC 1100, 1105, 1108, 1121, 1151, 2203, OR 2205; Math 1141 or 1151 or above, and Physics 1250 or above	Students need introductory content from any of these courses
EARTHSC 5780	Reflection Seismology	EARTHSC 1121, Math 1141 or 1151 or above, and Physics 1250 or above	EARTHSC 1100, 1105, 1108, 1121, 1151, 2203, OR 2205; Math 1141 or 1151 or above, and Physics 1250 or above	Students need introductory content from any of these courses
EARTHSC 5189.01	Field Geology I	EARTHSC 4423 and 4530 AND permission of instructor	EARTHSC 1100, 1121 OR 1200, EARTHSC 4530	Students need introductory lab content only for this portion; 4423 offers an unnecessary barrier for some
EARTHSC 5189.02	Field Geology II	EARTHSC 5189.01	EARTHSC 4421, 4423, and 5189.01	Adjusts for 5189.01 change

Table 2: Summary of credit hours required for the current program and required under the revised program

Current program credit hour requirements

	Geological Science	Earth System Science	Geophysics	Petroleum Geology and Geophysics
Preparation for the major	51	51	51	51
(overlap with existing GE)	15 (math & nat sci)	15	15	15
Major Requirements	31	30	30-31	30
Credit hours beyond GE requirements	51+31-15 =67	66	66-67	66

Revised Program credit hour requirements

	Geological Science	Climate Water and Environment	Geophysics
Preparation for the major	32	32-33	33
(overlap with existing GE)	12-15 (math & nat sci; 12 if not taking bio)	12-15	12
Major Requirements	33	33-34	30
Additional for Certificate	6	6	6
Minimum Additional for complementary minor	12 (e.g. Environmental Science), up to 3 overlap with our preparation for the major	12 (e.g. Environmental Science), up to 3 overlap with our preparation for the major	12 (e.g. physics, applied math), with no additional preparation
Minimum Additional for unrelated 2nd major	30	30	30
Credit hours beyond GE requirements	=59 w/cert =62 w/minor =77 w/related major =89 w/unrelated major	=56-61 w/cert =59-64 w/related minor	=57 w/cert =63 w/related minor

New certificates proposed, which may be used to fulfill the "focus and depth" requirement

Natural History Museum Curation (2 new course proposals)
Planetary Science, joint with Astronomy (1 new course proposal)
Petroleum Geology
Hydrogeology
Marine Science
Geodetic Geoscience (to be submitted 2020)
Paleontology (to be submitted 2020)

Approved minors & certificates

Any NMS minor
Geographic Information Systems (Geography)
Petroleum Engineering (CEBE)
Environmental Engineering
Surveying and Mapping
Education
Global Public Health
Science, Engineering and Public Policy
Environment, Economy, Development, and Sustainability (ENR)
Environmental Science (ENR)
Society and Environmental Science (ENR)
Soil Science (ENR)
Science and Technology Studies
Professional Writing

SCHOOL OF EARTH SCIENCES, OHIO STATE UNIVERSITY
REVISIONS TO B.S. PROGRAM: AUTUMN 2020

A) PREPARATION FOR THE MAJOR

Course number	Course name	Credit hours
Chem 1210	*General Chemistry 1:* First course for science majors, covering dimensional analysis, atomic structure, the mole, stoichiometry, chemical reactions, thermochemistry, electron configuration, bonding, molecular structure, gases, liquids, and solids.	5
Math 1151	*Calculus 1:* Differential and integral calculus of one real variable.	5
Math 1152	*Calculus 2:* Integral calculus, sequences and series, parametric curves, polar coordinates, (optional: vectors).	5
Physics 1250	*Physics 1:* Calculus-based introduction to classical physics: Newton's laws, fluids, thermodynamics, waves; for students in physical sciences, mathematics, and engineering.	5
One of		
Bio 1113	*Energy Transfer and Development:* Exploration of biology and biological principles; evolution and the origin of life, cellular structure and function, bioenergetics, and genetics.	4
Physics 1251	*Physics 2:* Calculus-based introduction to electricity and magnetism, simple optics, modern physics including special relativity and quantum mechanics; for students in physical sciences, mathematics, and engineering.	5
Chem 1220	*Chem 2:* Continuation of 1210 for science majors, covering solutions, kinetics, chemical equilibrium, solubility and ionic equilibria, qualitative analysis, thermodynamics, electrochemistry, descriptive chemistry, coordination compounds, and nuclear chemistry.	5
One of		
EARTHSC 1100	*Planet Earth: How It Works:* The materials of the Earth's crust, the processes that produce and modify them, the development of the Earth and its life forms through time, and responsible stewardship of the earth's resources.	4
EARTHSC 1121	*The Dynamic Earth:* Plate tectonics; rock forming processes; climate change; energy resources.	4
Or One of the following AND EARTHSC 1200		
EARTHSC 1105	*Geology of the National Parks:* Geologic processes, materials, and history revealed in geologic settings of the National Parks.	3
EARTHSC 1108	*Gemstones:* General introduction to gemstones, including the origin of gems, identification techniques, and the history of important gems.	3
EARTHSC 1151	*Natural Hazards:* Occurrence and causes of earthquakes, volcanoes, and related hazards, and impact on climate, society, and history.	3
EARTHSC 2203	*Environmental Geoscience:* Concepts and challenges of geological hazards and resources, environmental pollution, and health; regional and long-range planning; and global change and sustainability.	3
EARTHSC 2205	*The Planets:* Survey of the solar system's planets and moons with focus on surface environments, dynamics, and the ability to host life.	3
EARTHSC 2206(S)	*Principles of Oceanography:* Introduction to the four basic disciplines of oceanography: geological, chemical, physical, and biological. Relevance of oceanography in contemporary issues.	3
AND		
EARTHSC 1200 (new course)	*Introductory Earth Science Lab:* Laboratory application of basic earth sciences principles to the identification and categorization of rocks and minerals, use and construction of maps to solve geological problems, and analysis of Earth's physical processes.	1
Total semester hours in Preparation for the major		32-33

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

ALL BS programs:

Semester course number	Semester course name	Semester credit hours	Prereqs.
Complete:			
EARTHSC 2000 (new course)	*Preparation for Thesis and Careers in the Earth Sciences:* In this course, student will be 1) exposed to the wide diversity of research in Earth Sciences and potential careers in the Earth Sciences and 2) prepared for the senior thesis, which is a requirement for Earth Sciences BS majors.	1	---
EARTHSC 2245	*Introductory Data Analysis for Earth and Environmental Sciences:* Data analysis using cooperative learning environment; topics include data visualization, error analysis, error propagation, probability distributions, hypothesis testing, ANOVA, linear regression, and spatial statistics.	4	MATH 1141, 1151 or above, or concur
EARTHSC 4999.01(H)	*Undergraduate Research for Thesis in Earth Sciences:* Undergraduate research or creative activities in variable topics leading to completion of a B.S. thesis. To be taken during semester when thesis is turned in.	1 (graded)	Rank 4 in EARTHSC & permission of instructor
Complete at least 1 focused on the Science of Sustainability if not fulfilled in the preparation for the major			
EARTHSC 2122 (L)	*Climate and Life over Billions of years on Earth:* Origin and evolution of Earth, including its physical, chemical and biological components; principles of geologic inference and their application to interpreting Earth.	4	
EARTHSC 2155	*Energy and Environment:* Introduces and examines the fundamentals of energy sources, energy use, energy efficiency, and resulting environmental implications of the various energy supplies.	3	
EARTHSC 2203	*Environmental Geoscience:* Concepts and challenges of geological hazards and resources, environmental pollution, and health; regional and long-range planning; and global change and sustainability.	3	
EARTHSC 2204	*Exploring Water Issues:* Water on Earth, human impacts, and scientific and technological issues related to water resource development and conservation.	3	
EARTHSC 2206(S)	*Principles of Oceanography:* Introduction to the four basic disciplines of oceanography: geological, chemical, physical, and biological. Relevance of oceanography in contemporary issues.	3	
EARTHSC 2210	*Energy, Mineral Resources, and Society:* Geologic origin, world distribution, and uses of mineral resources critical to society; topics include mineral and fossil fuels, metallic ores, and industrial minerals.	3	
EARTHSC 3411	*Water Security for the 21st Century*: Examine the major issues that are contributing to the decline in quantity and quality of global freshwater resources and the resultant environmental and societal impacts.	3	
EARTHSC 4425	*Energy Resources and Sustainability (limbo)*: An examination of the problem of decreasing supplies of fossil fuel, alternative energy sources, and possible accommodations	3	A GE or GEC data anly course, and Soph standing or above
EARTHSC 5663	*Global Change and Sustainability (limbo)*: Analysis of Earth systems, global environmental change and options for sustainability	4	Sr or Grad standing, or permission of instructor
ENR 2100	*Introduction to Environmental Science:* Introduction to environmental science, the ecological foundation of environmental systems, the ecological impacts of environmental degradation by	3	

	humans, and strategies for sustainable management of environment and natural resources.		
ENR 5451	*Water Policy and Governance:* This class examines institutions to manage water effectively at a variety of levels - state, federal, and international- and analyzes how they affect water access and use in different areas (agriculture, energy, etc.). Students in the class will also engage in a careful examination of the sources of conflict and cooperation among water stakeholders on a regional and global scale.	3	
Complete the requirements for one subprogram (below) AND complete an approved Certificate, approved Minor, or any second major			

1) GEOLOGICAL SCIENCES subprogram:

Course number	Course name	Credit hours	Prereqs.
Everyone takes:			
EARTHSC 2122 (former 1122)	*Climate and Life over Billions of years on Earth:* Origin and evolution of Earth, including its physical, chemical and biological components; principles of geologic inference and their application to interpreting Earth.	4	If not used to satisfy the Science of Sustainability requirement
EARTHSC 4421	*Earth Materials:* Internal and external symmetry of minerals; relationship of physical properties to crystal structure; introduction to modern and traditional identification methods; sight identification of about 30 minerals.	3	Chem 1210
EARTHSC 4423	*Intro Petrology:* Origin, occurrence, association, and mineral composition of the common rocks; laboratory includes work by megascopic and microscopic methods.	3	EARTHSC 1100 OR 1121 OR 1200 & 4421
EARTHSC 4502	*Stratigraphy and Sedimentology:* Principles of, and procedures in, stratigraphy and sedimentation, illustrated by field and laboratory studies of sedimentary rocks.	4	EARTHSC 1100 OR 1121 OR 1200 & 1122 or 2122
EARTHSC 4530	*Structural Geology:* An introduction to the principles of rock deformation, the classification and physical origin of rock structures, and crustal tectonic processes.	4	EARTHSC 1100 OR 1121 OR 1200 & Physics 1250
EARTHSC 5189.01	*Field Geology 1:* Concentrated training in the basic essentials of field observation and mapping; the work is done in central Utah, with headquarters in Ephraim. Requires full time of student.	3	EARTHSC 1100 OR 1121 OR 1200, & 4530 & permission of instructor
EARTHSC 5189.02	*Field Geology 2:* Concentrated training in the basic essentials of field observation and mapping; the work is done in central Utah, with headquarters in Ephraim. Continuation of 5189.01. Requires full time of student.	3	EARTHSC 4423, 5189.02
TOTAL CREDITS, at least 21 of which must be at the 3XXX level or above		33	
Complete an approved certificate, minor, and any second major			
Minimum Required Hours to complete degree, including certificate/minor		33+6 = 39	

2) Climate, Water, and the Environment subprogram:

Course number	Course name	Credit hours	Prereqs.
Everyone takes (3 hours)			
EARTHSC 4450	*Water, Ice and Energy in the Earth System:* Earth's energy budget and the transfer of water between reservoirs. Processes that regulate water transfer, common measurement approaches, and the importance of water in geological processes, global change, and as a resource.	3	EARTHSC 1100, 1105, 1108, 1121, 1151, 2203, 2204, 2205, GEOG 3901, OR GEOG 5900; or permission of instructor
One Course on Earth Materials (3-4 hours):			
EARTHSC 2212	*Intro to Earth Materials (limbo):* A study of the common minerals and rocks, their associations, occurrences, identifying properties, and origin.	4(L)	EARTHSC 1121 and CHEM 1210 or above
EARTHSC 4421	*Earth Materials:* Internal and external symmetry of minerals; relationship of physical properties to crystal structure; introduction to modern and traditional identification methods; sight identification of about 30 minerals.	3(L)	CHEM 1210 or above
EARTHSC 4502	*Stratigraphy and Sedimentology:* Principles of, and procedures in, stratigraphy and sedimentation, illustrated by field and laboratory studies of sedimentary rocks.	4(L)	EARTHSC 1100, 1121, OR 1200; AND EARTHSC 1122 or 2122
Two Climate Classes (5-6 hours, including at least one EARTHSC course):			
EARTHSC 5206	*Advanced Oceanography:* Advanced study of geological, chemical, physical, and biological oceanography; their interactions; and their interactions with relevant current issues such as global change modeling, fisheries management, and energy exploration.	3	EARTHSC 1100 or 1105 or 1121 or graduate standing or permission of instructor
EARTHSC 5650	*Glaciology:* The fundamental processes controlling ice flow, glacier mass balance and the interaction of glaciers and ice sheets with the solid earth, ocean and atmosphere. Observational and computational methods are also addressed.	3	EARTHSC 4450 or permission of instructor
GEOG 3900	*Global Climate Change: Causes and Consequences:* Examines the natural and human factors that force changes in our climate and environment and explores strategies for a sustainable environment in the future.	3	---
GEOG 3901	*Global Climate and Environmental Change:* Examines both natural and social factors that force changes in our climate and environment and explores strategies for a sustainable environment in the future.	3	---
GEOG 5900	*Climatology:* An introduction to the fundamental physical and mathematical principles governing both day-to-day weather and the average of weather, or climate. Objectives are to understand the physical processes of the earth-atmosphere system, describe its weather features and climate characteristics today, and outline how they might change in the future as a result of global warming.	3	---
ENR 5268	*Soils and Climate Change:* Soil processes, abrupt climate change, trace gases and their properties, global C cycle, gaseous emissions, C-neutral fuels, carbon sequestration, Kyoto Treaty, trading of C credits.	2	---
Two Water Classes (6-7 hours, including at least one EARTHSC course):			
EARTHSC 5651	*Hydrogeology:* Geologic and hydrologic factors controlling the occurrence, movement, storage, and chemical quality of surface water and ground water; exploration, evaluation, development and management of water resources.	4 (L)	EARTHSC 1100, 1105, 1108, 1121, 1151, 2203, OR 2205; and Math 1152 or above
EARTHSC 5655	*Land Surface Hydrology:* Physical processes of land surface hydrology in the context of the global hydrologic	3	Math 1152 or above, ~~Chem 1210 or above~~,

	cycle. Consideration of the processes and mechanisms responsible for water and energy fluxes, with examples from various river basins.		and Physics 1250 or above
EARTHSC 5718	*Aquatic Geochemistry*: Examination of the processes that control chemical equilibria in natural waters: acid/base reactions, metal complexation/speciation and oxidation-reduction processes. Intended for students in EarthSci, CivilEn, and the Grad EnvSci program.	3	Chem 1220 (122) or above; and Math 1151 (152) or above; or equivalents.
ENR 4285	*Watershed Hydrology:* Covers hydrologic processes in watersheds, including precipitation, evapotranspiration, infiltration, runoff, and streamflow. We will evaluate how watershed characteristics, climate, and land use control these processes. In addition, we will discuss and practice current physical, chemical, and computational techniques for characterizing the hydrologic functioning of watersheds.	3 (L)	Chem 1210, and Math 1151 or 1156
EEOB 5420	*Aquatic Ecosystems:* Ecology of Inland Waters: A study of the physical, chemical, and biological factors influencing the biological productivity of inland waters, and of techniques and equipment used in evaluating them.	1.5	EEOB 3410
ENR 3280	*Water Quality Management:* Causes, consequences, and solutions of pollution in lakes, rivers, wetlands, and groundwater; analysis of the physical, chemical, and biological indicators of water quality.	2	
ENR 4260	*Soil Resource Management:* Degradation of the soil by erosion, compaction and salinity. Methods of preventing degradation and remediating existing problems. Special emphasis on conservation tillage, crop rotations, and irrigation management.	3	ENR 3000 or permission of instructor
Two Environment Classes (6 hours, including at least one EARTHSC course)			
EARTHSC 5621	*Introduction to Geochemistry:* Introduction to the chemistry of the solid Earth and hydrosphere describing the processes controlling the distribution of elements.	3	Rank 4 standing in EARTHSC or related field; Chem 1220 or above or permission of instructor
EARTHSC 5203	*Geo-Environment and Human Health:* Examine geo-environmental processes that are contributing to human health degradation and the resultant societal impacts.	3	EARTHSC 2245 or GE data analysis course or equivalent; Soph standing or above; or permission of instructor
ENVENG 3200	*Fundamentals of Environmental Engineering:* Quantitative assessment of water quality, air quality, and solid/hazardous waste management, with an emphasis on minimizing human health and environmental impacts through sustainable design.	3	Chem 1210
ENVENG 2100	*Environmental Engineering Analytical Methods:* Application of analytical methods to calculate, measure and interpret chemical characteristics of water, soil, and air.	3	Chem 1210 and 1220
ENR 3000	*Soil Science:* Introduction to soil physical, chemical, and biological properties related to land use, environmental quality, and crop production.	3	
TOTAL CREDITS, at least two of which must be a lab course		Core for all Earth Science BS students: 9 CWE requirements: 23-25 =32-34	
Complete an approved certificate, minor, and any second major			
Minimum Required Hours to complete degree, including certificate/minor		38-40	

3) Geophysics Subprogram

Complete the following courses (14-15 credit hours):

MATH 2153 or MATH 2173	*Calculus III:* Multivariable differential and integral calculus. *Engineering Mathematics B:* Multiple integrals, line integrals, vector fields, second order ordinary differential equations.	4 3	MATH 1152, 1172, 1534, 1544, 1181H, or 4181H
PHYSICS 2300	*Intermediate Mechanics I:* Vectors and kinematics; foundations of Newtonian mechanics; momentum, work, and energy; conservative and nonconservative forces; potentials; angular momentum; rotation about a fixed axis; rigid body motion; noninertial systems and fictitious forces.	4	PHYSICS 1251, PHYSICS 1251 1251H, or PHYSICS 1261. Concur: Math 2153, 2173, or above.
EARTHSC 4530	*Structural Geology:* An introduction to the principles of rock deformation, the classification and physical origin of rock structures, and crustal tectonic processes.	4	EARTHSC 1100 OR 1121 OR 1200 & Physics 1250
EARTHSC 4560	*Applied Geophysics:* Methods and techniques of pure and applied geophysics; geological interpretation of geophysical data.	3	EARTHSC 1100, 1105, 1108, 1121, 1151, 2203, OR 2205, Math 1151 & Physics 1250

Complete additional geophysics courses, up to 30 credit hours total (~2-3 courses):

EARTHSC 5641	*Geostatistics:* Applications of statistical methods to geoscience data, including linear error propagation, least-squares estimation, confidence interval estimation, analysis of variance. Role of computer graphics in data analysis.	3	Stat 5301 and Math 1152 or above, or permission of instructor
EARTHSC 5646	*Geodynamics:* Application of mathematical and physical methods to the solution of geologic problems in heat flow, plate tectonics, interior dynamics, mountain building, ground-water flow, river mechanics.	3	Math 1152, Physics 1250 & EARTHSC 4530, or permission of instructor
EARTHSC 5680	*Deep Earth Geophysics:* Methods and techniques for study of Earth's crust and interior, involving potential fields, seismology, and heat flow.	3	Math 1152 and Physics 1251
GEOSCIM 5612	*Introduction to Geodesy* (limbo)	3	EARTHSC 1121, Math 1152
GEOSCIM 5781	*Geodesy & Geodynamics:* Crustal motion geodesy, reference frame realization and station trajectory analysis, plate motion and Euler's theorem, earthquake deformation cycle, elastic and viscoelastic responses to surface loading, numerical methods.	3	Math 1152 or above, or Physics 1251, or permission of instructor
EARTHSC 5310	*Remote Sensing in the Earth Sciences:* 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.	3	EARTHSC 1100, 1105, 1108, 1121, 1151, 2203, OR 2205; and MATH 1141 or 1151 or above, and Physics 1250 or above; or grad standing; or permission of instructor
EARTHSC 5687	*Borehole Geophysics:* Principles and applications of borehole geophysical practices in the energy industry and in scientific drilling.	3	EARTHSC 1100, 1105, 1108, 1121, 1151, 2203, OR 2205; Math 1141 or 1151 or above, and Physics 1250 or above
EARTHSC 5751	*Quantitative Reservoir Modeling:* Principles of analytical and numerical techniques in modeling single- and multiphase flow in gas, oil, and water (aquifer) reservoirs. Development of Matlab code for two- and three-dimensional flow in porous media.	4	EARTHSC 2245 & Math 1152, or permission of instructor

EARTHSC 5780	*Reflection Seismology:* Basics of reflection seismic data processing and interpretation, using petroleum industry standard seismic processing software, hardware, and data.	4	EARTHSC 1100, 1105, 1108, 1121, 1151, 2203, OR 2205; Math 1141 or 1151 or above, and Physics 1250 or above

TOTAL CREDITS		Core for all Earth Science BS students: 9 GP requirements: 23-25=30	
Complete an approved certificate, minor, and any second major			
Minimum Required Hours to complete degree, including certificate/minor		36	

PART II: *Current* Advising Sheets

First Last name.xxx

EARTH SCIENCES B.S. DEGREE (GEOLOGICAL SCIENCES TRACK)

B.S. Checklist	Term	Year	Credits	Check
EarthSci 1121:	_____	_____	_____4____	_____
EarthSci 1122:	_____	_____	_____4____	_____
Biology 1113:	_____	_____	_____4____	_____
Chemistry 1210:	_____	_____	_____5____	_____
Physics 1250:	_____	_____	_____5____	_____
Chem 1220/Phys 1251:	_____	_____	_____5____	_____
Math 1151:	_____	_____	_____5____	_____
Math 1152:	_____	_____	_____5____	_____
EarthSci 2245:	_____Sp___	_____	_____4____	_____
_____:	_____	_____	_____	_____
_____:	_____	_____	_____	_____
EarthSci 4421:	_____Au___	_____	_____3____	_____
EarthSci 4423:	_____Au_____	_____	_____3____	_____
EarthSci 4530:	_____Sp_____	_____	_____4____	_____
EarthSci 5189.01:	_____Su___	_____	_____3____	_____
EarthSci 5189.02:	_____Su___	_____	_____3____	_____
EarthSci 4999.01:	_____	_____	_____1____	_____
EarthSci 4501:	____Sp____	_____	_____4____	_____
EarthSci 4502:	____Au____	_____	_____4____	_____
EarthSci 5XXX	_____	_____	___3–4____	_____
EarthSci 5XXX	_____	_____	___3–4____	_____

Autumn 2019

Spring 2020

Summer 2020

Autumn 2020

Spring 2021

Summer 2021

Autumn 2021

Spring 2022

Summer 2022

Autumn 2022

Spring 2023

EARTH SCIENCES B.S. DEGREE, EARTH SYSTEM SCIENCE

B.S. Checklist	Term	Year	Credits	Check
ES 1121:	_____	_____	____4_____	_____
ES 1122:	_____	_____	____4_____	_____
Biology 1113:	_____	_____	____4_____	_____
Chemistry 1210:	_____	_____	____5_____	_____
Physics 1250:	_____	_____	____5_____	_____
Chem 1220/Phys 1251:	_____	_____	____5_____	_____
Math 1151:	_____	_____	____5_____	_____
Math 1152:	_____	_____	____5_____	_____
EarthSci 2245:	_____Sp___	_____	____4_____	_____
_____:	_____	_____	_____	_____
_____:	_____	_____	_____	_____
EarthSci ____:	_____	_____	_____3____	_____
EarthSci ____:	_____	_____	_____4____	_____
EarthSci ____:	_____	_____	_____3____	_____
EarthSci ____:	_____	_____	_____4____	_____
EarthSci 4999.01:	_____	_____	_____1____	_____
EarthSci 5191/4998/5xxx:	_____	_____	_____3____	_____
ES 4/5xxx:	_____	_____	_____	_____
ES 4/5xxx:	_____	_____	_____	_____
_____:	_____	_____	_____	_____
_____:	_____	_____	_____	_____

Autumn 2019

Spring 2020

Summer2020

Autumn 2020

Spring 2021

Summer2021

Autumn 2021

Spring 2022

Autumn 2022

Spring 2023

EARTH SCIENCES B.S. DEGREE (GEOPHYSICS TRACK)

B.S. Checklist	Term	Year	Credits	Check
EarthSci 1121:	_____	_____	_____4____	_____
EarthSci 1122:	_____	_____	_____4____	_____
Biology 1113:	_____	_____	_____4____	_____
Chemistry 1210:	_____	_____	_____5____	_____
Physics 1250:	_____	_____	_____5____	_____
Physics 1251:	_____	_____	_____5____	_____
Math 1151:	_____	_____	_____5____	_____
Math 1152:	_____	_____	_____5____	_____
EarthSci 2245:	_____Sp___	_____	_____4____	_____
_____:	_____	_____	_____	_____
_____:	_____	_____	_____	_____
EarthSci 4421:	_____Au___	_____	_____3____	_____
EarthSci 4423:	_____Au___	_____	_____3____	_____
EarthSci 4999.01:	_____	_____	_____1____	_____
EarthSci :	_____	_____	_____	_____
EarthSci :	_____	_____	_____	_____
EarthSci :	_____	_____	_____	_____
EarthSci :	_____	_____	_____	_____
EarthSci :	_____	_____	_____	_____
EarthSci :	_____	_____	_____	_____
EarthSci :	_____	_____	_____	_____
EarthSci :	_____	_____	_____	_____

Part I

Part II

11 hours

Autumn 2019

Spring 2020

Summer2020

Autumn 2020

Spring 2021

Summer2021

Autumn 2021

Spring 2022

Summer2022

Autumn 2022

Spring 2023

EARTH SCIENCES B.S. DEGREE (PETROLEUM G&G TRACK)

B.S. Checklist	Term	Year	Credits	Check
EarthSci 1121:	_____	_____	_____4____	_____
EarthSci 1122:	_____	_____	_____4____	_____
Biology 1113:	_____	_____	_____4____	_____
Chemistry 1210:	_____	_____	_____5____	_____
Physics 1250:	_____	_____	_____5____	_____
Chem1220/Phys 1251:	_____	_____	_____5____	_____
Math 1151:	_____	_____	_____5____	_____
Math 1152:	_____	_____	_____5____	_____
EarthSci 2245:	_____Sp___	_____	_____4___	_____
_____:	_____	_____	_____	_____
_____:	_____	_____	_____	_____
EarthSci 4421:	_____Au___	_____	_____3____	_____
EarthSci 4423:	_____Au_____	_____	_____3____	_____
EarthSci 4502:	_____Au_____	_____	_____4____	_____
EarthSci 4530:	_____Sp_____	_____	_____4____	_____
EarthSci 5661:	_____Sp_____	_____	_____4____	_____
EarthSci 4999.01:	_____	_____	_____1____	_____
EarthSci 5687/4560:	____Sp____	_____	_____3____	_____
EarthSci 5780:	____Au_____	_____	_____4____	_____
EarthSci 5189.01:	_____Su___	_____	_____3____	_____
EarthSci 5189.02:	_____Su___	_____	_____3____	_____
EarthSci 4/5XXX	_____	_____	___3 or 4____	_____
EarthSci 4/5XXX	_____	_____	___3 or 4____	_____
EarthSci 4/5XXX	_____	_____	___3 or 4____	_____

Pick one

Pick three (9 hours minimum)

Autumn 2019

Spring 2020

Summer2020

Autumn 2020

Spring 2021

Summer2021

Autumn 2021

Spring 2022

Summer2022

Autumn 2022

Spring 2023

PART IV Sample 4-year plans:

Earth Science B.S. Sample 4-Year Plan, Geological Sciences Subprogram						
	Autumn Semester	**Cr Hrs**	**Spring Semester**	**Cr Hrs**		
Year 1	ASC 1110	1	CHEM 1210 (prep)	5		
	EARTHSC 1151 (prep)	3	Math 1151: Calculus I (prep)	5		
	GE Writing Level 1	3	EARTHSC 1200 (prep)	1		
	GE Foreign Language I	4	GE Foreign Language 2	4		
	Elective/GE	3				
	Semester Total Hours	**15**	**Semester Total Hours**	**15**	**1st Year**	**30**
Year 2	EARTHSC 2000 (major)	1	EARTHSC SUSTAIN (major)	3		
	MATH 1152 (prep)_	5	EARTHSC 2245 (major/GE data anal)	4		
	EARTHSC 2122 (major)	4	GE Writing Level 2	3		
	GE Foreign Language 3	4	Physics 1250	5		
	Semester Total Hours	**14**	**Semester Total Hours**	**15**	**2nd Year**	**29**
Year 3	EARTHSC 4421 (major)	3	EARTHSC 4530 (major)	4		
	EARTHSC 4423 (major)	3	Bio 1113/Chem 1220/Phys 1251 (prep)	4-5		
	EARTHSC 4502 (major)	4	GE Cultural & Ideas or Hist. Study	3		
	GE Social Sciences	3	GE Social Sciences	3		
	elective	3				
	Semester Total Hours	**16**	**Semester Total Hours**	**14-15**	**3rd Year**	**30-31**
Summer	EARTHSC 5189.01 (major)	3				
	EARTHSC 5189.02 (major)	3				
	Semester Total Hours	**6**				
Year 4	Certificate class	3	EARTHSC 4999.01 (major)	1		
	GE Historical Study	3	Certificate class	3		
	GE Arts	3	elective	3		
	elective	3	elective	3		
	elective	3	GE Literature	3		
	Semester Total Hours	15	**Semester Total Hours**	13	**4th Year**	**34**
					Total Hours	**123**

Earth Science B.S. Sample 4-Year Plan, Climate, Water, Environment Subprogram						
	Autumn Semester	**Cr Hrs**	**Spring Semester**	**Cr Hrs**		
Year 1	ASC 1110	1	CHEM 1210 (prep)	5		
	EARTHSC 1105 (prep)	3	Math 1151: Calculus I (prep)	5		
	GE Writing Level 1	3	EARTHSC 1200 (prep)	1		
	GE Foreign Language I	4	GE Foreign Language 2	4		
	Elective	3				
	Semester Total Hours	**14**	**Semester Total Hours**	**15**	**1st Year**	**29**
Year 2	EARTHSC 2000 (major)	1	Climate class #1	3		
	MATH 1152 (prep)_	5	EARTHSC 2245 (major/GE data anal)	4		
	EARTHSC SUSTAIN (major)	3	GE Writing Level 2	3		
	GE Foreign Language 3	4	EARTHSC 4450	3		
	elective	3	elective	3		
	Semester Total Hours	**17**	**Semester Total Hours**	**18**	**2nd Year**	**35**
Year 3	EARTHSC 4421/2212/4502 (major)	3-4	Climate class #2	3		
	Environment class #1	3	Bio 1113/Chem 1220/Phys 1251 (prep)	4-5		
	Water class #1	4	GE Cultural & Ideas or Hist. Study	3		
	GE Social Sciences	3	GE Social Sciences	3		
	elective	3				
	Semester Total Hours	**16-17**	**Semester Total Hours**	**14-15**	**3rd Year**	**30-33**
Year 4	Certificate class	3	EARTHSC 4999.01	1		
	Environment class #2	3	Certificate class	3		
	GE Historical Study	3	Water class #2	3		
	GE Arts	3	GE Literature	3		
	Elective	3	Elective	3		
	Semester Total Hours	**15**	**Semester Total Hours**	13	**4th Year**	**28**

Total Hours	**122-125**

Earth Science B.S. Sample 4-Year Plan, Geophysics Subprogram						
	Autumn Semester	**Cr Hrs**	**Spring Semester**	**Cr Hrs**		
Year 1	ASC 1110	1	Math 1152: Calculus II (prep)	5		
	Math 1151: Calculus I (prep)	5	Physics 1250: (prep)	5		
	GE Writing Level 1	3	GE Foreign Language 2	4		
	GE Foreign Language I	4	elective	3		
	elective	3				
	Semester Total Hours	**16**	**Semester Total Hours**	**17**	**1st Year**	**30**
Year 2	EARTHSC 2000 (major)	1	EARTHSC SUSTAIN (major)	3		
	MATH 2153 (major)_	4	EARTHSC 2245 (major/GE data anal)	4		
	EARTHSC 1121 (major)	4	GE Writing Level 2	3		
	GE Foreign Language 3	4	CHEM 1210 (prep)	5		
	Semester Total Hours	**13**	**Semester Total Hours**	**15**	**2nd Year**	**28**
Year 3	Physics 2300 (major)	4	EARTHSC 4530 (major)	4		
	Geophysics Elective	3-4	EARTHSC 4560 (major)	3		
	GE Social Sciences	3	GE Cultural & Ideas or Hist. Study	3		
	elective	3	GE Social Sciences	3		
	elective	3	elective	3		
	Semester Total Hours	**16-17**	**Semester Total Hours**	**16**	**3rd Year**	**32-33**
Year 4	Certificate class	3	EARTHSC 4999.01	1		
	GE Historical Study	3	Geophysics Elective	3		
	GE Arts	3	Certificate class	3		
	elective	3	GE Literature	3		
	elective	3	elective	3		
	Semester Total Hours	**15**	**Semester Total Hours**	13	**4th Year**	**28**
					Total Hours	**121**

Transition policy: The School of Earth Sciences commits to permitting any student already declared as a BS Earth Sciences major to complete their current subprogram plan, through 4 years after the adoption of this revision. Any current student may transition to the new plan once implemented upon request, with reasonable accommodations made for substitutions as necessary.

First Last name.xxx

EARTH SCIENCES B.S. DEGREE (GEOLOGICAL SCIENCES TRACK)

B.S. Checklist	Term	Year	Credits	Check
Chemistry 1210:	_____	_____	_____5____	_____
Physics 1250:	_____	_____	_____5____	_____
Math 1151:	_____	_____	_____5____	_____
Math 1152:	_____	_____	_____5____	_____
Bio 1113/Chem 1220/Phys 1251:				
	_____	_____	_____4____	_____
EarthSc 1121/1100/____:				
	_____	_____	_____	_____
EarthSc 1200:	_____	_____	_____1____	_____
EarthSc 2000:	_____	_____	_____1____	_____
EarthSci 2245:	_____Sp___	_____	_____4____	_____
Sci Sus: ES/ENR ___)	_____	_____	_____3____	_____
EarthSci 2122:	_____	_____	_____4____	_____
EarthSci 4421:	_____Au___	_____	_____3____	_____
EarthSci 4423:	_____Au_____	_____	_____3____	_____
EarthSci 4502:	____Au____	_____	_____4____	_____
EarthSci 4530:	_____Sp_____	_____	_____4____	_____
EarthSci 5189.01:	_____Su___	_____	_____3____	_____
EarthSci 5189.02:	_____Su___	_____	_____3____	_____
EarthSci 4999.01:	_____	_____	_____1____	_____
EarthSc _____:	_____	_____	_____	_____

MINOR/CERTIFICATE/Double Major_____

Autumn 2019
Spring 2020
Summer 2020
Autumn 2020
Spring 2021
Summer 2021
Autumn 2021
Spring 2022
Summer 2022
Autumn 2022
Spring 2023

First Last
name.xxx

EARTH SCIENCES B.S. DEGREE (CWE TRACK)

B.S. Checklist	Term	Year	Credits	Check
Chemistry 1210:	_____	_____	_____5____	_____
Physics 1250:	_____	_____	_____5____	_____
Math 1151:	_____	_____	_____5____	_____
Math 1152:	_____	_____	_____5____	_____
Bio 1113/Chem 1220/Phys 1251:				
	_____	_____	_____4____	_____
EarthSc 1121/1100/____:				
	_____	_____	_____	_____
EarthSc 1200 (if needed):	_____	_____	_____1____	_____
EarthSc 2000:	_____	_____	_____1____	_____
EarthSci 2245:	_____Sp___	_____	_____4____	_____
Sci Sus: ES/ENR ___:	_____	_____	_____3____	_____
EarthSci 4450:	_____	_____	_____4____	_____
EarthSci 2212/4421/4502:				
	_____Au___	_____	_____	_____
2 Climate Classes				
EarthSci_____:	_____	_____	_____	_____
_____:	_____	_____	_____	_____
2 Water Classes:				
EarthSci _____:	_____	_____	_____	_____
_____:	_____	_____	_____	_____
2 Environment Classes:				
EarthSci _____:	_____	_____	_____3____	_____
_____:	_____	_____	_____	_____

MINOR/CERTIFICATE/Double Major_____

Autumn 2019
Spring 2020
Summer 2020
Autumn 2020
Spring 2021
Summer 2021
Autumn 2021
Spring 2022
Summer 2022
Autumn 2022
Spring 2023

August 28, 2019

First Last
name.xxx

EARTH SCIENCES B.S. DEGREE (GEOPHYSICS TRACK)

B.S. Checklist	Term	Year	Credits	Check
Chemistry 1210:	_____	_____	_____5____	_____
Physics 1250:	_____	_____	_____5____	_____
Math 1151:	_____	_____	_____5____	_____
Math 1152:	_____	_____	_____5____	_____
Phys 1251:	_____	_____	_____4____	_____
EarthSc 1121/1100/____:				
	_____	_____	_____	_____
EarthSc 1200, if needed:	_____	_____	_____1____	_____
EarthSc 2000:	_____	_____	_____1____	_____
EarthSci 2245:	_____Sp___	_____	_____4____	_____
Sci Sus: ES/ENR ___:	_____	_____	_____3____	_____
Math 2153:	_____	_____	_____4____	_____
Phys 2300:	_____Au___	_____	_____	_____
EarthSci 4530:	_____Sp____	_____	_____4____	_____
EarthSci 4560:	_____Sp____	_____	_____3____	_____
EarthSc ____:	_____	_____	_____	_____
EarthSc ____:	_____	_____	_____	_____
EarthSc ____:	_____	_____	_____	_____

MINOR/CERTIFICATE/Double Major_____

Autumn 2019
Spring 2020
Summer 2020
Autumn 2020
Spring 2021
Summer 2021
Autumn 2021
Spring 2022
Summer 2022
Autumn 2022
Spring 2023

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	BS program required /elective
Earth Sciences 1100	Planet Earth: How it works	B	B	B	B	B	B	O-prep
Earth Sciences 1105	Geology of the National Parks	B	B	B		B	B	O-prep
Earth Sciences 1108	Gemstones	B	B	B		B	B	O-prep
Earth Sciences 1121	The Dynamic Earth	B	B	B	B	B	B	O-prep
Earth Sciences 1151	Natural Hazards	B	B	B	B	B	B	O-prep
Earth Sciences 2203	Environmental Geoscience	B	B	B		B	B	O-prep
Earth Sciences 2205	The Planets	B	B	B		B	B	O-prep O-PS
Earth Sciences 2206(&S)	Principles of Oceanography	B	B	B		B	B	O-prep O-SS
Earth Sciences 1200	Introductory Earth Science Lab		B	B	B	B	B	O-prep
Earth Sciences 2000	Preparation for Thesis and Careers in the Earth Sciences	B-I	B-I	B-I		B-I		R-GS R-GP R-CWE
Earth Sciences 2122	Climate and Life over Billions of years on Earth	B-I	B-I	B-I	B-I	B-I		O-SS R-GS
Earth Sciences 2155	Energy and Environment	B-I	B-I	B-I	B-I	B-I		O-SS
Earth Sciences 2203	Environmental Geoscience	B-I	B-I	B-I	B-I	B-I		O-SS
Earth Sciences 2204	Exploring Water Issues	B-I	B-I	B-I	B-I	B-I		O-SS
Earth Sciences 2210	Energy, Mineral Resources, and Society	B-I	B-I	B-I	B-I	B-I		O-SS
Earth Sciences 2212	Intro to Earth Materials	B-I	B-I	B-I	B-I	B-I		O-CWE
Earth Sciences 3411	Water Security for the 21st Century	I	I	I	I	I		O-SS

Earth Sciences 2245	Introductory Data Analysis for Earth and Environmental Sciences	B-I	B-I	B-I	B-I	B-I		R-GS R-CWE R-GP
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 5310	Remote Sensing in the Earth Sciences	A	A	A	A		A	O-GP O-PS O-MS
Earth Sciences 4421	Earth Materials	I	I	I	I	I	I	R-GS O-CWE O-CWE O-MC
Earth Sciences 4423	Introductory Petrology	I	I	I	I	I	I	R-GS O-MC
Earth Sciences 4425	Energy Resources and Sustainability	I	I	I	I	I	I	O-SS
Earth Sciences 4450	Water, Ice, and Energy in the Earth System	I	I	I	I	I	I	R-CWE O-MS O-HG
Earth Sciences 4501	Paleontology	I	I	I	I	I	I	O-MC
Earth Sciences 4502	Stratigraphy and Sedimentation	I	I	I	I	I	I	R-GS O-CWE O-MC
Earth Sciences 4530	Structural Geology	I	I	I	I	I	I	R-GS R-GP
Earth Sciences 4560	Applied Geophysics	I	I	I	I	I	I	R-GP O-PS O-PG
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	
Earth Sciences 4999.01	Undergraduate Thesis in Earth Sciences	I - A	I - A	I - A	I - A	I - A	I - A	R-GS R-CWE R-GP
Earth Sciences 4999.01H	Honors Undergraduate Thesis in Earth Sciences	A	A	A	A	A	A	
Earth Sciences 5189.01	Field Geology I	I - A	I - A	I - A	I - A	I - A	I - A	R-GS R-PG O-MC

Earth Sciences 5189.02	Field Geology II	A	A	A	A	A	A	R-GS O-PG
Earth Sciences 5191	Internship in the Earth Sciences	I - A	I - A	I - A	I - A	I - A	I - A	
Earth Sciences 5191.01	Museum Internship	A	A	A	A	A	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	
Earth Sciences 5203	Geo-environment and Human Health	A	A	A	A	A	A	O-CWE O-HG
Earth Sciences 5205	Planetary Science	A	A	A	A	A	A	R-PS
Earth Sciences 5206	Advanced Oceanography	A	A	A	A	A	A	R-MS O-CWE
Earth Sciences 5501	Museum Databases	A	A	A	A	A	A	O-MC
Earth Sciences 5550	Geomorphology	I-A	I-A	I-A	I-A	I-A	I-A	O-PS O-HG
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	O-MS
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	
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	O-CWE O-HG
Earth Sciences 5622	Stable Isotope Biogeo chemistry	A	A	A	A	A	A	O-MS
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	
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	O-GP
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	O-GP O-PS
Earth Sciences 5650	Glaciology	A	A	A	A	A	A	O-CWE
Earth Sciences 5651	Hydrogeology	A	A	A	A	A	A	O-CWE O-GP R-HG
Earth Sciences 5655	Land Surface Hydrology	A	A	A	A	A	A	O-CWE O-HG
Earth Sciences 5660	Geology of Metallic Deposits	A	A	A	A	A	A	
Earth Sciences 5661	Petroleum Geology	A	A	A	A	A	A	O-PG
Earth Sciences 5663	Global Change and Sustainability in the Earth System	A	A	A	A	A	A	O-SS
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	O-GP O-PS
Earth Sciences 5687	Borehole Geophysics	A	A	A	A	A	A	O-GP O-PG
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	
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 Ground-Water Flow Modeling	A	A	A	A	A	A	O-PG O-HG
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	O-MS O-PG
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	O-GP O-PS
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

Program Course Listing:
R- Required
O - one of multiple option
prep - preparation (all BS programs)
SS – science of sustainability (all BS programs)
GS – Geological Sciences subprogram
CWE- Climate Water Environment subprogram
GP- Geophysics subprogram
MS – Marine Science certificate
PS- Planetary Science certificate
HG- Hydrogeology certificate
MC – Museum Curation certificate
PG- Petroleum Geology certificate