

**UNDERGRADUATE COUNCIL
Request for Change(s)**

Originating unit requesting change _____ Geological Sciences _____

Type of Change requested:

- | | | |
|---|---|--|
| <input type="checkbox"/> Course number(s) | <input type="checkbox"/> Course prerequisite(s) | <input type="checkbox"/> Program title |
| <input type="checkbox"/> Course title | <input type="checkbox"/> Drop course(s) | <input type="checkbox"/> Program description |
| <input type="checkbox"/> Course description | <input type="checkbox"/> Drop program(s) | <input checked="" type="checkbox"/> Program requirements |

Semester and year change(s) take effect: _____ Fall 2021 _____

Appropriate computer abbreviation if course title is more than 30 spaces: _____

Briefly summarize the change requested:

Changes to the requirements for our Earth Systems Science degree are being requested to make the degree congruent with similar programs, nationally. Changes include the introduction and selection of courses to 1) strengthen students' foundational knowledge on key aspects of Earth System Science, and 2) develop experiential-based knowledge and skillsets commensurate of an emerging expert in the discipline.

Catalog copy

Present catalog copy (paste-up from catalog is acceptable).

Proposed change(s). (Include exact catalog copy as desired. Underline changes)

Requirements

The program requires a minimum of 36 hours on a 126-hour degree consisting of:

Requirements

The program requires a minimum of 45 hours on a 126-hour degree consisting of:

Required Geology/Environmental Science courses: 36 hours

Earth Systems Science FUNDAMENTALS:

ENSC 10143	Contemporary Environmental Issues	GEOL 10113	Understanding the Earth
GEOL 10113	Understanding the Earth	GEOL 20111	Introduction to Geological Sciences
ENSC 30363	Introduction to Geospatial Technology	GEOL 20113	Introduction to Earth Systems Science
GEOL 50523	Introduction to Geographic Information System	GEOL 30243	Sedimentology
GEOL 30443	Earth Materials	GEOL 40443	Natural Hazards and Disasters
GEOL 30413	Evolution of Plate Boundaries	GEOL 50523	Intro. to Geographic Information Systems
	OR	GEOL 30112	Geoscience Education Research
GEOL 30423	Structural Geology	GEOL 40693	Soils in the Environment
ENSC 50703	Environmental Compliance	GEOL 30103	Science, Scientists and Society

Choose one from ENV LEADERSHIP GROUP:

ENSC 50793	Environmental Sustainability
ENSC 40193	Environmental Stewardship Seminar

Choose one from GEOLOGY GROUP:

GEOL 30573	Stratigraphy
GEOL 40313	Invertebrate Paleontology
GEOL 30243	Sedimentology
GEOL 40970	Special Problems

Choose one from: LAND SURFACE GROUP:

GEOL 40493	Geomorphology
GEOL 40393	Soils in the Environment

Choose one from: WATER GROUP:

ENSC 50723	Water and Wastewater Technology
GEOL 50493	Physical Hydrology
ENSC 50763	Groundwater Hydrology
ENSC 50403	Rivers in the Landscape

Choose one from: FIELD RESEARCH GROUP:

ENSC 30403	Field Methods
GEOL 50713	Environmental Geology
ENSC 50613	Chemical Analysis of Environmental
ENSC 30453	Wildlife Research Project

Associated Requirements - 28-29 hours (required and elective)

BIOL 10003	Contemporary Issues in Biology
	OR
BIOL 30613	Natural History
CHEM 10113	General Chemistry I
MATH 10043	Elementary Statistics
MATH 10524	Calculus I
	OR
MATH 10283	Applied Calculus

Earth System Science SPECIALIZATIONS:

Students select a general track **or** ONE of the following four specializations:

- 1) GEOSPATIAL SCIENCE AND TECHNOLOGY
- 2) HYDROLOGIC SCIENCE
- 3) BIOGEOCHEMISTRY
- 4) EARTH SCIENCE EDUCATION

Track/Specialization require a minimum of 21 credit hours. At least 3 credit hours should be from undergraduate research directly related to the SPECIALIZATION. Courses within the Track/Specialization will be selected in consultation with a departmental advisor.

Associated Requirements - 29 hours (required and elective)

BIOL 10003	Contemporary Issues in Biology
CHEM 10113	General Chemistry I
MATH 10043	Elementary Statistics
MATH 10524	Calculus I
PHYS 10154	General Physics I with Laboratory

12 additional hours of:

Science, engineering, math or computer science electives selected with department approval.

12 additional hours of:

Science engineering, math or computer science electives
selected with department approval.

1. What is the justification for the change(s) requested?

National trends point to the increasing diversification of the Earth Sciences to address grand global challenges related to a rapidly changing Earth and increasing pressures on its limited resources. This has led to many Geology departments introducing Earth System Science, or similar degrees, in addition to the traditional Geology degree. The continued rise in these complementary degrees at both undergraduate and graduate levels can be seen via a google search of “Earth System Science degrees”. The emergence of this field of study has also been chronicled in several recent peer-reviewed articles e.g. [The emergence and evolution of Earth System Science](#)

The focus of Earth System Science degrees and the impetus for this requested change is to provide students with the transdisciplinary and integrative skillset needed for understanding 1) Earth as a system driven by interactions between its geology, chemistry, biology and physics; 2) the integration of technology, data science and modeling into the study of Earth system dynamics and 3) cause, impacts and solutions to a changing Earth from a fundamental science perspective.

The current curriculum is a carry-over from the old Applied Geoscience degree (replaced by Earth Systems Science in Fall 2020) which was useful as a technical degree but was limited in the scope of skillsets and post-graduation options for students. That is, the scope of the inherited Applied Geosciences degree is limited to local and regional entry-level support/technician roles in the energy or environmental sectors with little to no prospects for competitive graduate school matriculation. With recent unit alignments and strategic hiring of faculty - at the departmental, college and university-level we see this as the optimal time to be pro-active in taking steps to revamp our programs in-line with emerging trends and peers across the nation. We anticipate that such a shift will increase our student numbers as well as put our students in a more competitive position for a broader range and higher-level jobs as well as matriculation into top level graduate programs at the nexus of science, engineering and technology.

2. If applicable, explain how the change(s) will affect the current program outcomes and assessment mechanisms.

We anticipate, and is targeting, two specific program outcomes with this change. The first is an increase in enrollment of students, who do not want a traditional geology degree, but are interested in understanding how the Earth works as a system and subsequently, how this understanding can be parlayed into the development of the critical-thinking and practical skills needed to address grand challenges associated with complex issues such as climate, pollution or resource scarcity. We believe there is a great likelihood of this happening based on 1) increasing student interest in interdisciplinary education and 2) evidence from literature and other geology programs which show increasing or stable numbers with introduction of Earth System Science degrees. For example, it is quite normal for the number of students in traditional geology programs to fluctuate with crude oil prices. Evidence coming out of programs with an Earth System Science, or similar degree, option point to increasing or stable student numbers irrespective of crude oil prices.

Our second targeted outcome is an increase in the placement of students in top level graduate programs and a broader range and higher-level jobs. The best entry-level STEM jobs (more often than not) require highly specialized skillsets that are only achievable via immersive experiential learning experiences. Most top-level programs are now focusing their resources on PhD (rather than two-year MS) programs. The consequence of this, is that acceptance to these programs (with financial support) typically requires either a MS degree or a BS with exceptional undergraduate research experience. We are taking a proactive approach in preparing our students to be competitive for these opportunities.

3. **Faculty Resources:** How will the unit provide faculty support for this change and any other impact this change may have on other current departmental listings.

In the last five years our departmental hires have been very strategic and supports this shift in our field towards the systems science focus. The new requirements being proposed for our ESS degree introduces three new courses (GEOL 20113, GEOL 40443 and GEOL 30112). Each were proposed and will be taught by three of these hires (Drs. Harvey, Gebremichael and Pelch, respectively) as part of their regular course rotations.

The expertise of Drs. Harvey, Gebremichael and Pelch also covers the respective specialization tracks being introduced; with each proposing these specializations and indicating their intentions to serve as advisors to students within these tracks. That is,

- 1. Harvey's expertise covers Biogeochemistry and the Hydrologic Sciences. He will provide advising support to students in the BIOGEO and HYDRO tracks.*
- 2. Gebremichael's expertise covers Geospatial Science and the Hydrologic Sciences. He will provide advising support to students in GST and HYDRO tracks.*
- 3. Pelch's expertise covers Geoscience/Earth Science Education. He will provide advising support to students in the EarthED track.*

It is important to note that none of this advising will interfere or collide with advising for our other degrees which are currently being handled by other faculty. Namely, Drs. Xie and Hanson for BS in Geology and Dr. Alsleben for our MS in Geology.

Other key strategies we used in designing the new requirements for our ESS degree without

requiring additional resources, were:

1. *The leveraging of current GEOL course offerings into a synergetic, streamlined manner that facilitate deep experiential learning, while developing fundamental skillsets and expertise in preparation for graduate education or entry-level employment in specialized areas of the Earth Sciences and related fields.*
2. *The leveraging of relevant, frequently-offered courses in other departments that are a key part of the TCU core, offerings to non-majors or non-specialist courses. We are using these courses to facilitate the development of the breadth needed to understand the systems perspective and/or to form the fundamental science aspects of a specialized track. For example, the leveraging of frequently-offered, non-specialized courses in Computer Science, Pyschology, Chemistry and Biology provides a good foundation for deep dive into Big Data, Science Education, Climate Modeling and Mitigation trends in Earth Science.*
3. *Intra-departmental team teaching, team mentoring and leveraging of our broad range of expertise to support our students' integration of ideas and thought processes within our discipline. Our expertise in the department covers every aspect of the Earth System, as well as time and spatial scales. Over the last few years, we have had great success with this approach of team teaching/mentoring and will continue to do so in enacting the new requirements of our ESS curriculum. For example, GEOL 20111 is currently team taught with each faculty leading the discussions for an assigned week. A team-taught approach will be adopted for the GEOL 30103 requirement; with a team mentoring approach also used to support the research requirements.*

As a result of these strategies and the inclusive design process, we do not anticipate any immediate changes in the support needed by our faculty. We do recognize that, with time, some modifications of course offerings may be necessary but we will address those on an as-needed basis.

4. **Educational Resources:** Will this change require additional resources not currently available (e.g. space, equipment, library, other)? YES
If yes, list additional resources needed. NO

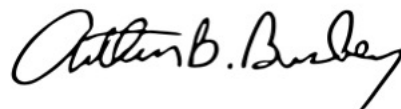
No additional resources needed for current requested change to program.

5. If this change affects other units of the University, include a statement signed by the chairperson(s) of the affected unit(s).

We do not anticipate that the request will would affect the functioning of other departments. However, we anticipate that as the curriculum evolves, collaboration with other departments may be necessary. We will engage such departments as the need arises.

6. If cross-listed, provide evidence of approval by all curriculum committees appropriate to both the originating and cross-listed units.

Not Applicable



Approval signature of chairperson of originating unit