ABET
Self-Study Report

for the

Geological Engineering Program

at

University of Utah

Salt Lake City, UT 84112

June 30, 2015

CONFIDENTIAL

The information supplied in this Self-Study Report is for the confidential use of ABET and its authorized agents, and will not be disclosed without authorization of the institution concerned, except for summary data not identifiable to a specific institution.
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BACKGROUND INFORMATION

A. Contact Information

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B. Program History

The geological engineering program at the University of Utah was first accredited by ABET in 1952 at which time the program was located in the Department of Geological and Mining Engineering. Upon establishment of an independent Department of Mining Engineering, administration of the geological engineering program was given to the Department of Geology and Geophysics. Since 1952, the geological engineering program has undergone numerous curriculum and faculty changes over the years while maintaining continuous ABET accreditation. The last general review was conducted during the 2009-2010 cycle. Notable changes that have taken place since the last general review include:

- Implementation of a combined BS/MS degree in geological engineering
- Implementation of a new associates degree in geological engineering at Salt Lake Community College as a way to increase enrollment in the program
- Dropping two courses from the curriculum to bring total credit hours for the program into line with other University of Utah engineering programs

C. Options

The ABET accredited geological engineering program in the Department of Geology and Geophysics currently has a single B.S. degree option which can also be earned as combined BS/MS degree option. Non-accredited M.S. and Ph.D. degrees in geological engineering are offered.
D. Program Delivery Modes

Courses taught in the geological engineering program generally are offered during daytime hours of the standard academic year (late August to early May). Exceptions are the 4 credit, summer field course (GEO 4550, “Field Geology for Geological Engineers”) and the surveying course (MG EN 2400 “Surveying and Global Positioning”) which are offered by the Department of Mining Engineering in the summer.

E. Program Locations

The geological engineering program is offered exclusively at the University of Utah although science, math, and preliminary engineering courses are often taken by transfer students from community colleges (primarily Salt Lake Community College).

F. Public Disclosure

Program Education Objectives, Student Outcomes, annual student enrollment and graduation data are posted at http://www.earth.utah.edu/undergraduate/bs-geo-engineering.php.

G. Deficiencies, Weaknesses or Concerns from Previous Evaluation(s) and the Actions Taken to Address Them

Two weaknesses were identified during the 2009-2010 evaluation of the University of Utah geological engineering program. What follows is verbatim from a written report of the August 23, 2012 meeting of the Engineering Accreditation Commission (EAC) of ABET:

1. Criterion 2. Program Educational Objectives. The previous review cited that new objectives consistent with the ABET definition had been put in place but no evidence was provided of assessment and evaluation to demonstrate the degree to which these objectives were attained. The process for evaluating the previous objectives had involved survey current student and did not appear to be suitable evaluating the new objectives. Criterion 2 requires an assessment and evaluation process that periodically documents and demonstrates the degree to which the program educational objectives are attained.

The interim report described a new, statistically-based plan for regular, periodic surveys of alumni and included data from one round of the surveys. However, the alumni survey instrument itself does not adequately embody the program educational objectives and is the only assessment mechanism mentioned in the report. Additional information from the program included the results of the geological engineering committee meeting on February 4, 2011 and provided a mapping of the survey questions to the program educational objectives. Without this mapping, the relationship between some of the survey questions and their mapped objectives is not readily apparent. Faculty members in the program were not able to identify the relationship between the survey questions and the program educational objectives with certainty. Ambiguity among the alumni and other constituencies.
in this regard may result in inaccurate or incorrectly mapped response data that will fail to demonstrate the degree to which the program educational objectives are attained. The current assessment and evaluation process does not appear to provide a mechanism to determine the degree to which the program educational objectives are attained nor was this aspect of the criterion documented by the program.

- The weakness remains unresolved.
- Due process response: The EAC acknowledges receipt of documentation demonstrating that new questions have been added to the alumni survey in order to address the program educational objectives more explicitly. Additionally, the documentation provided information about an employer survey that has been developed to assist in determining attainment of program educational objectives. Results from both the revised alumni survey and the employer survey were included in the documentation, along an evaluation of the survey results that demonstrates the degree to which program educational objectives are being attained.

- The weakness is resolved.

2. **Criterion 3. Programs Outcomes.** The previous review cited that new strategy had been implemented for documenting and demonstrating the degree to which program outcomes are attained but that the new process had not yet gone through a cycle of assessment and evaluation. Additionally, the review noted that the Geological Engineering Committee had agreed to examine the feasibility of integrating the CLEAR (Communication, Leadership, Ethics, and Research) program into their curriculum to ensure continued attainment of effective communication skills by students in the geological engineering program.

The interim report included examples of student work and course-level evaluations resulting from an assessment plan that maps the geology and geophysics courses in the geological engineering program to the program outcomes. According to the plan, each program outcome is assessed using assignments in at least three primary courses. Each primary course has identified metrics and expected proficiency levels for the relevant outcomes. Supplemental information provided minutes of the geological engineering committee meeting of August 26, 2010, where faculty members discussed how to interpret successful attainment of outcomes. The documentation noted that as students progress through the curriculum the attainment of a specific outcome will occur using assignments of increasing complexity that culminate in the capstone design course in the senior year. The attainment of a specific outcome in each course is enforced through implementation of remedial actions so that each student reaches the expected proficiency level for the outcome in that course. The remedial actions enforce the attainment of the designated outcomes in each primary course, thus ensuring the attainment of the outcome at the program level. The chair of the geological engineering committee will review the outcome results each semester and bring to the committee’s attention any courses needing remedial actions. The report provided examples of remedial actions in some courses.

- The weakness is resolved.
GENERAL CRITERIA

CRITERION 1. STUDENTS

A. Student Admissions

Students are admitted to the University of Utah geological engineering program upon meeting the broad University admission requirements, followed by an informal advising session with a program faculty member.

Admission to the University of Utah. Freshman admitted to the University of Utah are required to have graduated or expect to graduate from an accredited high school within the semester preceding matriculation at the University. Since 1991, students have been admitted using an “admissions index”, essentially a matrix of high school GPA and standardized test scores.

Admission to the Geological Engineering Program. There is no formal procedure for admission to the geological engineering program. Like most engineering programs nationwide, the University of Utah geological engineering program is intellectually rigorous and demanding. For this reason, students who express interest in the geological engineering degree are advised by a member of the geological engineering faculty regarding their interests, goals, and (particularly) their preparation in basic science and math. This informal screening can typically determine whether a prospective student is appropriate for the program or not.

B. Evaluating Student Performance

Student progress toward completion of their degrees is accomplished using a variety of tools. The implementation of the PeopleSoft software package campus-wide at the University of Utah now allows considerable flexibility in implementing these tools. Of particular importance is the DARS (Degree Auditing Reporting System) report. The DARS is essentially an advising report that shows progress toward a degree. Students can request a degree audit report, at no cost through the Web, for the degree program(s) in which they are enrolled or for degree programs in which they are interested. DARS is also intended to help students select courses for future enrollment. University major and graduation (i.e. general education and bachelor's degree) requirements are displayed and DARS shows which of these requirements the student has already fulfilled and which remain to be completed. The report has instructions for easy interpretation and students can print copies and take it with them when they see their academic advisors.

DARS reports can also be accessed through the departmental academic coordinator who, upon request, can provide the reports to members of the geological engineering committee. DARS reports are used by the geological engineering committee in three ways:
- **Geological Engineering Committee meetings.** The Geological Engineering Committee, consisting of the geological engineering faculty members meets on an irregular basis and as part of its function often discusses individual student issues. Typically, these involve course substitutions and are generally dealt with by a vote of the committee. E-mail is also sometimes used to deal with the various program issues.

- **Annual student advising.** Each academic year, a faculty member meets with all geological engineering majors to fill out or update 2-year advising sheets (described below) (see Criterion 1.D) that are often reviewed in conjunction with the DARS report. This procedure has proven effective in preventing students from enrolling in courses without the necessary pre-requisites.

- **Final monitoring of the DARS report.** Prior to graduation, the DARS report must be signed by the principle advisor and department chair to ensure that all graduation requirements (including passing the FE exam) have been met.

### C. Transfer Students and Transfer Courses

As an institution, the formal policy of the University of Utah regarding the transfer of academic credit from other institutions of higher learning is stated in the University of Utah general catalog:

“Transfer credit earned in residence at other accredited collegiate institutions is normally accepted for advanced standing if the work is parallel in nature to programs offered at this university, and if grades of D- or better have been earned in the credited courses. No transfer credit toward a bachelor's degree is allowed for courses graded below D-. Please note: Prerequisite courses and major courses may require higher grades. Check with your major adviser for additional information. The transfer evaluation and summary of transfer credit is subject to audit and re-evaluation.”

In addition to this general policy, the University of Utah has entered into articulation agreements with all public institutions of higher learning in the state including 4-year institutions (Utah State University, Weber State University, Southern Utah University, Utah Valley University), community colleges (Dixie State College, College of Eastern Utah, Snow College, and Salt Lake Community College) and two private schools (Brigham Young University and BYU-Idaho) (Table 1C.1). All but the last institution are within the State of Utah. Courses covered by the articulation agreement have been examined by officials of the University administration to ensure that course content is equivalent and are automatically accepted as transfer credits by the participating institutions. Courses covered by these articulation agreements include nearly all of the lower division science and engineering courses in the geological engineering curriculum. It is important to point out that over the past decade, the number of transfer students from Utah community colleges to the University of Utah has increased dramatically as a result of specific policies adopted by the State Board of Regents that encourage high school students to enroll in 2-year institutions prior to completing their majors at a 4-year institution.
<table>
<thead>
<tr>
<th>COURSE</th>
<th>U OF U</th>
<th>BYU</th>
<th>BYU-Idaho</th>
<th>DIXIE</th>
<th>SLCC</th>
<th>SNOW</th>
<th>SUU</th>
<th>USU</th>
<th>UVU</th>
<th>WEBER</th>
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<td>CEEN</td>
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<td>MG EN</td>
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<td>CEEN</td>
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<tr>
<td>Earth Materials I</td>
<td>GEO</td>
<td>GEOL</td>
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<tr>
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<td>GEOL</td>
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<tr>
<td>Field Methods</td>
<td>GEO</td>
<td>GEOL</td>
<td>3080</td>
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<td>Groundwater Remed.</td>
<td>GEO</td>
<td>GEOL</td>
<td>3080</td>
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<tr>
<td>Strat. Sediment.</td>
<td>GEO</td>
<td>GEOL</td>
<td>3080</td>
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</tbody>
</table>
Requirements for transferring credit into the geological engineering program is more rigorous than that of the University in that we require (1) a minimum grade of C- for any course in the program and (2) examination and approval of individual courses by the programs academic advisor and, if necessary, the Geological Engineering Committee as a whole. If courses are not explicitly listed in the table shown below, a petition (Figure 1C.1) is completed by the student. Research is conducted by the faculty advisor (investigating the relevant institution, program, and associated course description). If the proposed substitution is found to be acceptable, the form is signed by the geological engineering advisor and departmental chair, and entered into the student’s DARS report.
UNDERGRADUATE STUDENT PETITION
GEOLICAL ENGINEERING

REQUEST: (State clearly and concisely the request you are making. Use exact course numbers and course titles):


REASONS: (Explain fully the circumstances which require this request. If necessary use reverse side. If the cause of this petition is to prevent delay in graduation, record on page 2 your projected schedule for each semester until your expected date of graduation.)


Date: ___________________________ Signature: ___________________________

Major: ___________________________ Name (Please print): ___________________________

Current graduation: __________ (month) __________ (year) Address: ___________________________

Revised graduation: __________ (month) __________ (year)

Approval Recommended Not Approved Denied

Geological Engineering Advisor Date ___________________________ Department Chair Date ___________________________

Approval Recommended Not Recommended

Geological Engineering Committee Chair Date ___________________________
D. Advising and Career Guidance

The goal of the geological engineering program at the University of Utah is to produce intellectually curious and technically capable graduates that have the capability to solve complex problems in the engineered use of earth materials. Academic advising is a critical component of achieving this goal.

The small number of students relative to the number of faculty in the geological engineering program promotes a high degree of formal and informal interaction both inside and outside the classroom that aid in meeting the Program Objectives. Academic advising is accomplished through formal individual advising sessions as well as informal interactions with students.

Individual advising

In response to pre-2003 ABET review concerns about a small percentage of geological engineering students not receiving formal advising, the following policy was adopted by the Geological Engineering Committee in 2002. Promulgated by the department chair, this policy reads:

“To help students maintain high scholastic standards, the department has appointed advisors to consult with them about their academic progress. The student is assigned an advisor in the selected field upon declaring a major. We recommend that students consult their advisors at least twice each year. Students in Geological Engineering must consult their advisor at least once each year. Failure to do so will result in dismissal from the degree program.”

Thus, at least formal, one-on-one advising session per year with a geological engineering faculty member is a requirement for remaining in the program. At each advising session, the student and faculty member discuss courses taken during the past year, courses yet to be taken, and the proposed timetable for graduation. Issues such as taking the Fundamentals of Engineering (FE) exam and the total number of engineering credits in an individual student’s curriculum are also a part of the advising sessions.

A written document is produced by these advising sessions: a 2-year plan for students that is filled out for the students during the advising session (Figure 1.D1). This aids in documenting courses taken within the context of an idealized, 4-year course of study. Aspects of the advising spreadsheets that merit special attention:

- **Tracking of appropriate prerequisites for classes.** Since the University of Utah does not require major advisors to sign off on student registration of classes, making certain that courses are not taken out of sequence is a critical part of tracking student progress.

- **Tracking of progression toward graduation within the idealized, 4-year course of study.** The 2-year advising sheet (Figure 1D.1) allows geological engineering faculty to evaluate whether course sequences are being followed, provides an easily viewed check on the rate at which students are progressing though their degrees, and makes faculty aware of class scheduling conflicts.
**Figure 1.D1. Template for 2-year advising of geological engineering majors**

**University of Utah Geological Engineering Advising Form**

**2-Year Schedule Planner**

<table>
<thead>
<tr>
<th>Student: ____________________________</th>
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</thead>
<tbody>
<tr>
<td><strong>SEMESTER:</strong> ______________________</td>
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<tr>
<td>Course</td>
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<td>__________</td>
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<td>__________</td>
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<tr>
<td><strong>SEMESTER:</strong> ______________________</td>
</tr>
<tr>
<td>Course</td>
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<td>__________</td>
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<td>__________</td>
</tr>
</tbody>
</table>

Comments: ____________________________

______________________________

Signatures:

________________               __________________
Student                        Date

________________               __________________
Advisor                        Date
E. Work in Lieu of Courses

The Geological Engineering program does not permit work in lieu of courses with the exception of advanced placement courses in math, science, or general education that accompany entering students at the University of Utah.

F. Graduation Requirements

The graduation requirements for the Bachelor of Science in Geological Engineering at the University of Utah are summarized in Figure 1F.1 below.

University graduation requirements can be found at: http://ugs.utah.edu/gen-ed-reqs/index.php. Requirements for a B.S. in Geological Engineering from the University of Utah include:

1) Academic Standards
   a) Total Semester Credit Hours – minimum of 122 credit hours required
   b) Upper Division Credit Hours – at least 40 of the required 122 semester hours must be at the 3000-level or above; all College of Mines and Earth Science programs automatically satisfy this requirement
   c) Residency Hours – a minimum of 30 hours must be completed at the University of Utah; 20 of the last 30 hours must be completed at the University of Utah
   d) Minimum Cumulative GPA – a 2.0 GPA is required to stay in Good Standing at the University of Utah

2) General Education Requirements
   a) American Institutions (AI) – one course from approved list
   b) Lower Division Writing (WR2) – one course, typically Writing 2010
   c) Quantitative Reasoning (QA and QB) – one course in calculus or higher math satisfies both QA and QB
   d) Intellectual Exploration (IE) – Intellectual Exploration courses are divided into four areas: Fine Arts; Humanities; Physical, Life, and Applied Science; and Social and Behavioral Science. Students will take two courses in each area outside their major. Major requirements will clear the IE requirements in that area. For example, Engineering students must take two each of approved Fine Arts (FF), Humanities (HF), and Social/Behavioral Science (BF) courses. The Physical, Life, and Applied Science area is fulfilled automatically by the Geological Engineering major requirements of Chemistry (CHEM 1210) and Physics (PHYS 2210).

3) Bachelor's Degree Requirements
   a) Upper Division Communication/Writing (CW) – one course from the approved list; satisfied by GEO 4500 course
   b) Diversity (DV) – one course from the approved list; can also count for IE credit
c) Upper Division International Requirement (IR) – one course from the approved list or participation in an approved study abroad program; required of all students beginning their enrollment at the University Fall 2007 or after; can also count for IE credit

d) Bachelor of Science Upper Division Quantitative Intensive Requirement (QI) – two upper-division courses from the approved list; satisfied by GEO 3010, 3060, and 5150 (major requirements)
Figure 1.F1. Current graduation requirements for the Geological Engineering Program at the University of Utah

<table>
<thead>
<tr>
<th>NAME:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>FRESHMAN YEAR</th>
<th>JUNIOR YEAR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fall Semester</strong></td>
<td><strong>Fall Semester</strong></td>
</tr>
<tr>
<td>CHEM 1210 General Chemistry I</td>
<td>4</td>
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<tr>
<td>CHEM 1215 General Chemistry Lab I</td>
<td>1</td>
</tr>
<tr>
<td>MATH 1210 Calculus I</td>
<td>4</td>
</tr>
<tr>
<td>Gen Ed</td>
<td>3</td>
</tr>
<tr>
<td>Gen Ed</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total Hours</strong></td>
<td>15</td>
</tr>
</tbody>
</table>

| **Spring Semester** | **Spring Semester** |
| CHEM 1220 General Chemistry II | 4 | CVEEN 3310 Geotechnical Eng I | 3 |
| CHEM 1225 General Chemistry Lab II | 1 | GEO 3060 Structural Geology/Tectonics | 3 |
| MATH 1220 Calculus II | 4 | GEO 3010 Geophysics | 3 |
| Gen Ed | 3 | GEO 4500 Field Methods | 3 |
| Gen Ed | 3 | Gen Ed | 3 |
| **Total Hours** | 15 |

| **Summer Term** | |
| GEO 4550 Field Geology for Engineers | 4 |
| **Total Hours** | 4 |

<table>
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<tr>
<th>SOPHOMORE YEAR</th>
<th>SENIOR YEAR</th>
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<tbody>
<tr>
<td><strong>Fall Semester</strong></td>
<td><strong>Fall Semester</strong></td>
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<tr>
<td>CVEEN 2110 Statics</td>
<td>3</td>
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<tr>
<td>GEO 3075 Introduction to Geological Engineering</td>
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<td>GEO 3070 Earth Materials for Eng</td>
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<td>MATH 2210 Calculus III</td>
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<td>PHYS 2210 Physics for Sci and Engg</td>
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<td>PHYS 2219 Physics Lab for Sci and Engg I</td>
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<tr>
<td><strong>Total Hours</strong></td>
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</table>

| **Spring Semester** | **Spring Semester** |
| MATH 2250 ODE's and Linear Algebra | 3 | GEO 5150 Geo Eng Design | 4 |
| MG EN 1050 Technical Communications (CAD) | 2 | GEO 5360 Fluid Dynamics | 3 |
| MG EN 5150 Mechanics of Materials | 3 | GEO 5385 Intro to Groundwater Modeling | 1 |
| GEO 3090 Earth Materials II | 3 | GEO 5390 Subsurf Remed & Remediation | 3 |
| PHYS 2220 Physics for Sci and Engg | 4 | technical elective | 3 |
| **Total Hours** | 15 | **Total Hours** | 14 |

**Total Credits for Degree** 126
Ensuring that graduation requirements are met for a given student is aided considerably by the PeopleSoft/DARS software system described in Section B above. The DARS report gives a complete record of student progress toward their degree. As a student approaches time to graduate, the DARS report must be signed by the advisor of the geological engineering program who ensures that the student has taken all appropriate courses.

**G. Transcripts of Recent Graduates**

Transcripts of recent graduates will be provided as required by the ABET Team Chair. Please note that the geological engineering program has only one degree option.
CRITERION 2. PROGRAM EDUCATIONAL OBJECTIVES

A. Mission Statement

The following mission statement of the University of Utah can be found at:
http://admin.utah.edu/office_of_the_president/university-mission-statement

“The mission of the University of Utah is to serve the people of Utah and the world through the discovery, creation and application of knowledge; through the dissemination of knowledge by teaching, publication, artistic presentation and technology transfer; and through community engagement. As a preeminent research and teaching university with national and global reach, the University cultivates an academic environment in which the highest standards of intellectual integrity and scholarship are practiced. Students at the University learn from and collaborate with faculty who are at the forefront of their disciplines. The University faculty and staff are committed to helping students excel. We zealously preserve academic freedom, promote diversity and equal opportunity, and respect individual beliefs. We advance rigorous interdisciplinary inquiry, international involvement, and social responsibility.”

The following is the mission statement of the College of Mines and Earth Sciences which can be found at http://www.cmes.utah.edu/about/mission.php:

The mission of the College of Mines and Earth Sciences is:

- To educate and prepare professional earth scientists, geological engineers and earth science educators, meteorologists, and atmospheric scientists, physical and extractive metallurgists, mineral separation experts, and mining engineers.
- To engage in scholarly research activities in geology, geophysics, geological engineering, meteorology, physical and extractive metallurgy, mineral separation, and mining engineering.
- To disseminate newly acquired knowledge through timely publication of original research by faculty and students in all of the above fields.
- To educate the University community and the public about the composition and structure of Earth, processes that shape it, and its history and future.
- To provide professional service by providing knowledge about natural resources, methods of natural resource extraction, safety in industrial activities, metals extraction and modification, geologic hazards, the environment, and a sustainable Earth.
The following is the mission statement of the Department of Geology and Geophysics:

The mission of the Department of Geology and Geophysics is to:

- Train professional geoscientists and geological engineers of the highest caliber.
- Educate the University community and the public at large about the composition and structure of the Earth, the dynamic processes that shape the Earth, and the history and possible future of the Earth.
- Engage in scholarly research activities in order to acquire new knowledge of the Earth.
- Disseminate newly acquired knowledge to the scientific community via the timely publication of original research results by faculty and students.
- Provide professional service to the public sector by gathering and disseminating information regarding natural resources and geologic hazards, including earthquakes.

B. Program Educational Objectives

The University of Utah geological program objectives are given on the following website: http://www.earth.utah.edu/undergraduate/bs-geo-engineering.php

The goal of the Geological Engineering program at the University of Utah is to educate and train through teaching, research, and service the critical thinking and communication skills necessary to help solve engineering problems and design engineering systems within the context of the natural earth. Consistent with the departmental program mission, the program educational objectives of the Geological Engineering program are the following:

1) Graduates will be capable of utilizing their backgrounds in engineering and earth science to provide solutions to engineering problems within the context of the natural world. Areas of geological engineering practice might include fluid flow and contaminant transport in the subsurface; geo-mechanics (i.e., the behavior of earth materials), geo-engineering (i.e., design with earth materials); and discovery, development, and utilization of energy resources.

2) If employed as an engineer, the graduate will be prepared to obtain professional engineer registration, and will participate in professional societies and continuing education activities that work to improve their professional stature.

3) Graduates will strive to develop and maintain a professional environment that fosters honesty, integrity, and a strong engineering and work ethic.
C. Consistency of the Program Educational Objectives with the Mission of the Institution

The Wasatch Front of Utah and the entire Intermountain West of the United States faces a future in which natural resources, particularly water resources, will be under increasing pressure for development and/or reallocation. Like most communities in the world, ground and surface water pollution is a concern that must be dealt with. Large population growth also requires the addition of significant infrastructure along the Wasatch Front. The residential and business construction associated with growth has revealed natural hazards (principally landslides and debris flows) that were previously unrecognized but have caused significant property damage, or even loss of life. The possibility of a devastating earthquake (magnitude 7+) along the Wasatch Front has long been recognized and geological engineers are often called upon to map and evaluate active faults prior to development activities.

These issues are continuously in the public eye and geological engineers play a pivotal role in resolving the thorny technical issues surrounding water resource, natural resources, and geotechnical problems (as stated in Educational Objectives #1 and 2). Recent, high profile examples of previously unknown landslides destroying high-priced housing in the city of North Salt Lake and a historically large landslide in the Bingham Canyon copper mine illustrate the importance of educating geological engineers and how the program constituencies relate to the mission of the program as well as those of the department and college.

D. Program Constituencies

The program constituencies listed below meet annually to biannually to review the program and suggest improvements. The current makeup of the constituency committee represents a cross section of program faculty, students, alumni, and employers that breaks down into the following subgroups.

1) Professional Advisory Committee (PAC). Members of this committee are practicing geological engineers or engineering geologists from the local Utah area. They are chosen on the basis of their broad experience in small consulting companies, large corporations, and government, entities in the best position to evaluate whether geological engineering graduates meet the program educational objectives. The Professional Advisory Committee is composed of three members. During the 2009-2015, the decision was made to rotate one person off the board at a 2-3 year interval.

2) Alumni. Alumni serve as an informal review of the geological engineering program and its objectives. Alumni surveys provide feedback to the geological engineering program and informal contacts with alumni at professional meetings and reunions on campus are also valuable. Efforts are made for one member of the PAC to be an alumnus of the geological engineering program.

3) Geological Engineering Student Advisory Committee: This is an ad hoc group of upper class geological engineering students. The Geological Engineering Constituency meetings for the 2009-2015 period included students at the sophomore to senior level in their studies. Participation of these students helps promulgate educational objectives through the ranks of geological engineering majors.
4) *Extra-departmental Geological Engineering Program Faculty.* These are faculty members who teach courses in the geological engineering curriculum but are not faculty members of the Department of Geology and Geophysics.

5) *Departmental Program Faculty.* This consists of the current five members of the geological engineering faculty plus the department chair as an *ex officio* member.

**E. Process for Review of the Program Educational Objectives**

Program educational objectives are regularly discussed by the geological engineering faculty and periodically reviewed during constituency meetings. Prior to these meetings, the chair of the Geological Engineering Committee assembles relevant data and information for focused discussion by the group as a whole.

1. **Constituency Meetings**

Constituency groups are consulted during Geological Engineering Constituency Meetings held on an annual or biannual basis, depending on the urgency of particular issues. The purpose of the constituency meeting is to obtain input from a cross section of the program stakeholders regarding the nature of the program objectives, the degree of achievement of the program objectives, the tools by which the degree of achievement is assessed, and the changes in the program and its objectives that the assessments indicate should be considered. The makeup of the committee over the 2009-2015 period is listed here.

**Professional Advisory Committee (2009-2015)**

Mr. Craig V. Nelson (2001-2010)
Consulting Geologist
Western GeoLogic, LLC
Salt Lake City, UT

Mr. Geoffrey C. Bedell (2001-2012)
Senior Process Engineer
Kennecott Utah Corporation
Magna, UT

Dr. Ryan Cole (2009-2013)
Engineer
Gerhart Cole, Inc
Salt Lake City, UT

Dr. Steven Bowman (2010-present)
Director, Geologic Hazards Program
Utah Geological Survey
Salt Lake City, UT
Mr. Trent Parkhill (2013-present)
Senior Principle Engineer
Kleinfelder, Inc.
Salt Lake City, UT

Mr. Wynn John (2015-present)
Environmental Engineer
IHI Environmental
Salt Lake City, UT

**Geological Engineering Program Faculty (inter-departmental):**
Dr. Paul W. Jewell, Chair, 2011-present
Professor
Surface Water Hydrodynamics and Surface Processes

Dr. William P. Johnson
Professor
Subsurface Contaminant Transport

Dr. D.Kip Solomon
Professor
Groundwater Hydrology

Dr. Aurelian C. Trandafir, Chair, 2009-2011 (left the University, 2011)
Assistant Professor
Geological Engineering and Landslide Hazards

Dr. Jeffrey Moore (began at the University, 2013)
Assistant Professor
Geological Engineering and Landslide Hazards

Dr. Lisa Stright (began at the University, 2013)
Assistant Professor
Petroleum Geoscience and Engineering

Mr. Daniel Seeley
Staff Engineer, IGES, Inc
Geological Engineering, Geomechanics,

**Geological Engineering Program Faculty (extra-departmental)**
Dr. K. McCarter (Mining Engineering)
Professor
Mining Engineering
Constituency meetings were conducted four times between 2009-2015.

Date: October 1, 2009  
Attendees: Aurel Trandafir (Chair), Paul Jewell, Bill Johnson, Kip Solomon, Craig Nelson, Ryan Cole, Steve Bartlett, Kim McCarter, Bill Pariseau, Jesse Moyles (student), Brett Gregory (student), Bryant Bunnell (student)  
Significant agenda items: Revising program educational objectives; strategies for documenting program outcomes; response to 2009 ABET evaluation  
Results: Updated metrics for assessing program outcomes; incorporation of CLEAR (Communication, Leadership, Ethics, and Research) into the geological engineering program.

Date: April 29, 2010  
Attendees: Aurel Trandafir (Chair), Paul Jewell, Kip Solomon, Steve Bartlett, Kim McCarter, Bill Pariseau, Geoff Bedell, Steve Bowman, Jesse Moyles (student)  
Significant agenda items: Closer integration of geological engineering program with Department of Civil and Environmental Engineering, comparison of geological engineering curriculum to other GE programs in the U.S.  
Results: Integration of specific geological engineering courses as electives in civil engineering undergraduate program.

Date: December 13, 2013  
Attendees: Paul Jewell (Chair), Jeff Moore, Bill Johnson, Lisa Stright, Steve Bartlett, Mike Nelson, Trent Parkhill, Steve Bowman, Kevin Neville (student), Eric Thomas (student)  
Significant agenda items: Curriculum revision, possible split into three emphasis options, dropping courses to streamline current curriculum  
Results: No serious objections were raised to dropping MGEN 5040 (Engineering Design) and GEO 5370 (Contaminant Partitioning) from the curriculum as approved by the GE faculty; possibility of established three degree emphases in the program was discussed.
Date: April 29, 2015

Attendees: Paul Jewell (Chair), Jeff Moore, Bill Johnson, Kip Solomon, Lisa Stright, Dan Seely, Steve Bartlett, Kim McCarter, Trent Parkhill, Steve Bowman, Wynn John, Eric Thomas (student), Angie Grey (student)

Significant agenda items: Revision of educational objectives, relevance of Fundamentals of Engineering exam (no longer required in any form for programs in the College of Engineering)

Results: Minor revisions to educational objectives to be more in line with employment of recent graduates; continued requirement of passing the FE exam for the geological engineering program, issues to be revisited in the future.
2. Alumni Surveys

Alumni surveys are a useful component of assessing program educational objectives. Because of the limited number of graduates in the 2010-2012 period, only two surveys (2011, 2015) were undertaken.

**Figure 2.E1. Alumni survey used during 2009-2015**

### Survey Questions

<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>If you are employed as a geological engineer, how effective are you?</td>
<td>Not Effective  Very Effective</td>
</tr>
<tr>
<td></td>
<td>NA ( ) 0 ( ) 1 ( ) 2( ) 3( ) 4( )</td>
</tr>
<tr>
<td>If not employed as a geological engineer, do you feel that you could be?</td>
<td>Yes ( ) No ( )</td>
</tr>
<tr>
<td>If you were, how effective would you be?</td>
<td>Not Effective  Very Effective</td>
</tr>
<tr>
<td></td>
<td>NA ( ) 0 ( ) 1 ( ) 2( ) 3( ) 4( )</td>
</tr>
<tr>
<td>Are you a graduate student or have you completed graduate training in a professional discipline?</td>
<td>Yes ( ) No ( )</td>
</tr>
<tr>
<td>If yes, how effective was our Program in preparing you?</td>
<td>Not Effective  Very Effective</td>
</tr>
<tr>
<td></td>
<td>NA ( ) 0 ( ) 1 ( ) 2( ) 3( ) 4( )</td>
</tr>
<tr>
<td>If employed as an engineer, are you a PE or aspiring to be one?</td>
<td>Yes ( ) No ( )</td>
</tr>
<tr>
<td>Are you active in a professional organization that works to improve the engineering profession?</td>
<td>Yes ( ) No ( )</td>
</tr>
<tr>
<td>How effective was our program in preparing you for the role in society expected of a geological engineer (things such as strong work ethic and ethical behavior in the work place or graduate school)?</td>
<td>Not Effective  Very Effective</td>
</tr>
<tr>
<td></td>
<td>NA ( ) 0 ( ) 1( ) 2( ) 3( ) 4( )</td>
</tr>
</tbody>
</table>

**Summary**

The alumni survey results are summarized in Figure 2.E2. The relatively small numbers make specific conclusions difficult to define, however the results will be used with future constituency meetings since the number of students coming through the program in the past two years has been relatively high.
### Figure 2.E2. Alumni survey results

<table>
<thead>
<tr>
<th>Question</th>
<th>2011 survey: average 0 = not effective; 4 = very effective (number responding)</th>
<th>2015 survey average 0 = not effective; 4 = very effective (number responding)</th>
</tr>
</thead>
<tbody>
<tr>
<td>If you are employed as a geological engineer, how effective are you?</td>
<td>3.0 (4)</td>
<td>4.0 (2)</td>
</tr>
<tr>
<td>If not employed as a geological engineer, do you feel that you could be?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>If you were, how effective would you be?</td>
<td>2.5 (2)</td>
<td>3.2 (5)</td>
</tr>
<tr>
<td>Are you a graduate student or have you completed graduate training in a professional discipline?</td>
<td>3 yes (5)</td>
<td>3 yes (7)</td>
</tr>
<tr>
<td>If yes, how effective was our Program in preparing you?</td>
<td>2.7 (3)</td>
<td>3.6 (3)</td>
</tr>
<tr>
<td>If employed as an engineer, are you a PE or aspiring to be one?</td>
<td>5 yes, 0 no</td>
<td>4 yes, 2 no</td>
</tr>
<tr>
<td>Are you active in a professional organization that works to improve the engineering profession?</td>
<td>3 yes, 2 no</td>
<td>5 yes, 2 no</td>
</tr>
<tr>
<td>How effective was our program in preparing you for the role in society expected of a geological engineer (things such as strong work ethic and ethical behavior in the work place or graduate school)?</td>
<td>2.6 (5)</td>
<td>3.9 (8)</td>
</tr>
</tbody>
</table>

3. Employer Surveys

Employer surveys are a critical component of assessing program educational objectives. However, the limited number of graduates during the 2009-2015 period made this tool of somewhat limited use. Results are given below.
Figure 2.E3. Employer survey used during 2009-2015

Employer Survey

Privacy Statement: Your response is confidential and will be used by the Department only to assess our educational program.

The Geological Engineering program at the University of Utah is required by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology to assess how well this program is preparing graduates for their careers. Your response is very important to us and will help document our performance relative to the criteria established for engineering programs. Please take a few minutes and respond to the items presented below.

1. Personal information for individual completing the survey.

First name
MI
Last name

Company

Title

Address

City & State

Zip/Postal code

Country

Phone

email

2. Company information:

Please indicate the main area(s) of business for your organization. Check all that apply.

- Environmental Assessment
- Water resources
- Groundwater contamination and remediation
- Geotechnical engineering
- Geological hazards assessment
- Natural resource extraction
- Consulting
- Education
- Equipment/Supplies Sales
- Construction
- Government Agency
- Other

3. Contact with geological engineers from the University of Utah

Approximately how many engineers have worked under your supervision or as colleagues that you know are graduates of the geological engineering program at the University of Utah? Please do not identify individuals by name.
4. Indicate your level of overall satisfaction with the performance of geological engineers from the University of Utah

5. What are the critical (most important) skills (technical and nontechnical) desired in geological engineers that your organization hires?

6. Have geological engineers in your organization obtained a professional engineer license? If not, are they on track to obtain a PE?

7. Please indicate any current or future societal needs that the geological engineering program at Utah should prepare graduates to meet.

8. Please indicate how new geological engineers at your organization continue the learning process following graduation.

   - Participate in professional organizations
   - Read professional/trade journals
   - Attend short courses
   - Enroll in extension courses
   - Self-directed study
   - Other

9. Other comments or suggestions.

Employer survey summary

An employer survey was conducted in 2011 and 4 responses were received. With only two graduates between 2011 and 2013 (one of which entered the military) a second survey was not undertaken until spring 2015. Despite repeated e-mails, only one 2015 response was received and thus employer surveys are not addressed under Criterion 4, Continuous Improvement. A summary of the five responses from the 2011 and 2015 surveys is given here.

- How many geological engineering graduates from the University of Utah have worked under your supervision? **14 total**

- Level of satisfaction with performance of these geological engineers: “very satisfied”, “generally satisfied”, “very good”, “very high”, “extremely satisfied”.

- Critical skills desired in geological engineers: “written and verbal skills” (mentioned in all 5 responses), “good understanding of behavioral soil and rock properties and quality writing skills”, “broad range of technical knowledge; ability to apply existing skills to new problems; ability to work with other (soft and hard) technical disciplines”
• Have obtained or are on track to become professional engineers: \textit{12 total}

• Geological engineers continue to:
  
  o Participate in professional organizations – 5 of 5 responses
  o Read professional journals – 5 of 5 responses
  o Attend short courses – 5 of 5 responses
  o Enroll in extension courses – 1 of 5 responses
  o Self-directed study – 3 of 5 responses
CRITERION 3. STUDENT OUTCOMES

A. Student Outcomes

The program student outcomes that were established based on the program educational objectives, and utilized for assessment through the 2009-2015 period are the following:

a) an ability to apply knowledge of mathematics, science, and engineering
b) an ability to design and conduct experiments, as well as to analyze and interpret data
c) an ability to design a system, component, or process to meet desired needs
d) an ability to function on multi-disciplinary teams
e) an ability to identify, formulate, and solve engineering problems
f) an understanding of professional and ethical responsibility
g) an ability to communicate effectively
h) the broad education necessary to understand the impact of engineering solutions in a global and societal context
i) a recognition of the need for, and an ability to engage in life-long learning
j) a knowledge of contemporary issues
k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

B. Relationship of Student Outcomes to Program Educational Objectives

<table>
<thead>
<tr>
<th>OBJECTIVES</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
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<th>J</th>
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</tr>
</tbody>
</table>

Specifics regarding how student outcomes and selected specific courses prepare graduates to attain program educational objectives are given here as a flavor of how the three are connected. A more general mapping of educational objectives, student outcomes, and program courses is given under Criterion 5.
Educational objective #1:

Graduates will be capable of utilizing their backgrounds in engineering and earth science to provide solutions to engineering problems within the context of the natural world. Areas of geological engineering practice might include fluid flow and contaminant transport in the subsurface; geo-mechanics (i.e., the behavior of earth materials), geo-engineering (i.e., design with earth materials); and discovery, development, and utilization of energy resources.

Related student outcomes and specific course work:

a) an ability to apply knowledge of mathematics, science, and engineering. Basic math, science (including earth science, a key part of the natural world), and engineering are fundamental features of the geological engineering degree and a key to achieving Educational Objective #1. An understanding of the character and behavior of earth material is fundamental to this particular educational objective. Examples of specific course material used to achieve this outcome:

GEO 3075 (Introduction to Geological Engineering). Basic understanding an application of rock mass properties and their chemical makeup to stress, strain, and other properties of earth materials.

GEO 5350 (Groundwater): Basic understanding of sub-surface fluid flow in the natural world. Application of continuity equation and hydrostatics (integration of fluid pressure with depth). Formulation of groundwater flow equations in vector form, concepts of anisotropy and heterogeneity.

GEO 5360 (Fluid Dynamics of Earth Materials): Basic understanding of surface fluid flow in the natural world using force balances. Fluids examined include water, air, rock water mixtures, and magmas. Mathematical solution of boundary value problems of partial differential equations.

b) an ability to design and conduct experiments, as well as to analyze and interpret data. Providing solutions to engineering solutions as stated in Educational Objective #1 “requires conducting experiments and analyzing data”. Data collection in field, laboratory, and computational settings are all important aspects of experimental design. Understanding the shortcomings of data in all these settings is fundamental to achieving Educational Objective #1. Examples of specific course material used to achieve this outcome:

GEO 4550 (Field Geology for Geological Engineers): Design of a water diversion tunnel that involves rock mass characterization data in the field. Students are presented a real earth science problem to solve and a limited number of hours (4 to 12, depending on the project) to collect relevant and sufficient data. Individually and in groups (with lessening guidance from the instructor in successive projects), they develop hypotheses to be tested and design data collection strategies and schedules.
GEO 5360 (*Fluid Dynamics of Earth Materials*). Students conduct a series of hands-on experiments to confirm or invalidate the following principles: fluid statics, force balances, Bernoulli’s equation, fluid rheology, hydraulic jumps, and the shallow water wave equation. The ability to scale natural processes to a laboratory setting for experimental purposes is central to the course.

GEO 5385 (*Introduction to Groundwater Modeling*). The course applies modeling of sub-surface fluid flow in the natural world. Numerical experiments are conducted using state-of-the-art groundwater modeling software. Students learn the importance of initial and boundary conditions in the solution of the equation that governs groundwater flow, in addition to recognizing the inherent limitations such models and experiments. Examples include groundwater flow in a classic regional setting (the “Toth experiments”) and a groundwater contamination problem.

c) an ability to design a system, component, or process to meet desired needs. Providing solutions to engineering solutions as stated in Educational Objective #1 “requires the ability to design” systems, components, and processes. Natural media in geological engineering practice are typically rocks, water, or some combination of the two. Examples of specific courses used to achieve this outcome:

GEO 3075 (*Introduction to Geological Engineering*): Design with earth materials incorporated into the pillar design and depth of a tunnel system (final course project).

GEO 5150 (*Geological Engineering Design*): The course consists of a single, semester-long project of designing a highway embankment for a proposed railroad overpass bridge approach. Design is central to all aspects of the course.

GEO 5350 (*Groundwater*). Students evaluate a water resource problem. For example, an actual application to the State Engineer for changing a water right in Southern Utah has been evaluated. Students obtained background hydrologic information, performed simulations of drawdown, and made recommendations regarding whether or not the State of Utah should accept the application. This was an open-ended, design type problem where each student had to make decisions on the data to include, and the simulations to perform, in order to support their final recommendation (Final project B).

e) an ability to identify, formulate, and solve engineering problems. Graduates are expected to utilize “their backgrounds in engineering and earth science to provide solutions to engineering problems”. This blending of earth science and engineering is achieved by these courses:

GEO 5150 (*Geological Engineering Design*). The semester-long engineering problem in the course requires students to integrate data from a variety of sources including tests to determine index properties, compaction, consolidation, long-term settlement, hydraulic conductivity, and strength. The students then use the extensive data package to sharpen their data interpretation skills as well as employing their engineering judgement to formulate the final design problem.
GEO 5390 (Solute Transport and Subsurface Remediation). The design problem for the course is an open ended solution to a groundwater contamination problem. Students must formulate solutions using tools and knowledge that they have acquired throughout the curriculum (specifically, the physics and chemistry of groundwater) up to this point.

GEO 5760 (Stratigraphy and Sedimentary Processes). The final project fully involves earth science (stratigraphy, geophysics, and fluid flow), mathematics and engineering (drilling technology and borehole evaluation techniques) to evaluate resources and optimally to meet a stated drilling objective in a prospective oil field.

Educational objective #2:

*If employed as an engineer, the graduate will be prepared to obtain professional engineer registration, and will participate in professional societies and continuing education activities that work to improve their professional stature.*

In order for graduates to achieve Educational Objective #2, the geological engineering faculty train students in the skills needed to successfully participate in professional endeavors include such activities as professional meetings (including oral and written presentations), reading relevant journals, and reviewing manuscripts and proposals (both academic and industrial).

Obtaining Professional Engineer licensure is a critical component of Educational Objective #2. According to the National Council of Examiners for Engineering and Surveying:

“The (PE) exam is developed with questions that will require a variety of approaches and methodologies including design, analysis, and application”.

In this sense, obtaining a PE (Educational Objective #2) is closely related to the student outcomes inherent in Educational Objective #1. Student course work in the geological engineering program is aimed at giving students the tools to achieve the dual goals of both objectives. Furthermore, when the practicing engineer achieves PE status, he or she is necessarily exposed to many of the global and societal aspects (e.g., environmental regulations) of their profession (outcome h).

Student outcome and course work related to educational objective #2 include:

**d) an ability to function on multi-disciplinary teams.** Virtually all engineering activities involve some level of teamwork. Examples of courses that teach this approach include:

GEO 4500 (Field Methods). Students are divided into teams of 2-4 for the design and data collection phases of each project, and are explicitly required to solicit, consider, and respect ideas and opinions from each team member. (This is encouraged and reinforced through the awarding of “professional points”, worth 5-10% of the project grade.) They meet to formulate problem-solving strategies and collaboration in field data collection. They are also encouraged to collaborate on the preparation of maps, cross sections, stratigraphic columns, and stereoplots.
GEO 4550 (*Field Geology for Engineers*). Where possible, exercises are geared toward a team approach in projects that have constituted components of the course over the past several years. These include hydrologic characterization of the Matheson wetlands, near Moab, Utah; geologic hazard mapping along the Wasatch Front; and design of a tunnel in Big Cottonwood Canyon, Utah.

GEO 5390 (*Solute Transport and Subsurface Remediation*). The course projects are conducted as teams of 3-5 students. Course projects are evaluated by members of other teams, in addition to the course instructor.

g) *an ability to communicate effectively.* Effective communication is implied in the goals of Educational Objective #2. A large number of courses in the geological engineering curriculum involve significant report writing and giving oral presentations in classes. Selected lengthy written reports will be available for the program reviewer. The evidence of oral reports will be in the form of paper copies of Powerpoint presentations and instructor evaluations.

GEO 4500 (*Field Geology*) and GEO 4550 (*Field Geology for Geological Engineers*). GEO 4500 fills the University writing requirement for the degree. In addition the final reports for both the geologic hazards and geotechnical portions of GEO 4550 constitute evidence of student report writing capability.

GEO 5150 (*Geological Engineering Design*). The final design project is written up as a technical report of professional quality.

GEO 5390 (*Solute Transport and Subsurface Remediation*). The final project is presented in both written and oral form after having gone through criticism and evaluation by the instructor. The final product must be of professional quality that could be accepted for regulatory purposes.

h) *the broad education necessary to understand the impact of engineering solutions in a global and societal context.* Certain of the global and societal context is provided in the distribution requirements (general education courses) (Section 1F) of the degree. In addition, specific courses within the degree also help fulfill this outcome.

GEO 5150 (*Geological Engineering Design*). This outcome is directly assessed by asking the students to perform an independent study and prepare for the design problem in the course that includes a paragraph in the final technical report discussing the impact of a specific geological engineering problem in a global, environmental, and societal context.
A sample paragraph prepared by the student is as follows:

“... Landslides represent a major geologic hazard for the United States producing immense human and material losses annually. The socioeconomic effects from thousands of landslides that occur each year impact people, their homes, and possession; industrial establishments; and transportation, energy and communication lifelines (e.g., highways, railways, communication cables). The fast-growing human population causes the inhabited environment to expand into more unstable hillside areas, highlighting an increasing need for landslide mitigation and long-term slope stabilization measures. The objective of this report is to design and evaluate landslide mitigation measures to ensure long-term stability (with a safety factor of 1.35) of a natural slope in limit equilibrium composed of alluvial material underlain by competent bedrock ...”

GEO 5390 (Solute Transport and Subsurface Remediation): Students are exposed to the professional resources (e.g., EPA tools and regulations) and approaches to solving modern environmental problems.

GEO 5660 (Numerical Methods in the Geosciences): A variety of ecosystems models are incorporated into classroom exercises. The simplest are two-component predator-prey models which are then ramped up into real-world, multi-component ecosystems models of the sort used in environmental impact statements and other venues.

i) a recognition of the need for, and an ability to engage in life-long learning. This outcome is inherent to the participation in professional societies and continuing education component of Educational Objective #2. Examples from specific courses include:

GEO 3400 (Computational and Field Methods in Applied Geology). The use of remote sensing in earth sciences and geological engineering has exploded in recent years and now constitutes an important niche in these fields. Programming assignments show these new technologies can be procured and applied to real-world problems.

GEO 3075 (Introduction to Geological Engineering). An overview of the career path available to geological engineers is a part of the introduction of the course.

GEO 5150 (Geological Engineering Design). Surveys regarding possible involvement in professional societies are given to all students in the course. Inasmuch as this course is taken immediately prior to graduation, it will have the greatest impact on future professional development.

j) a knowledge of contemporary issues. Contemporary issues (both professional and non-professional) are common components of being involved in professional societies. Examples from specific courses include:

GEO 3075 (Introduction to Geological Engineering): A broad overview of the field and the role of geological engineers in the broader society are emphasized.
GEO 5150 (*Geological Engineering Design*): Similar approaches to explaining the role of geological engineering in broader society as GEO 3075, but given after have completed most of their curriculum.

GEO 5390 (*Solute Transport and Subsurface Remediation*). A knowledge of the latest EPA regulations and various acts of Congress regarding the environment (e.g., CERCLA) is worked into the course.

k) *an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.* Mastering modern engineering techniques is critical to gaining professional engineering licensure and the geological engineering and other faculty have endeavored to bring as many of these tools into their courses as possible. Examples of courses include:

GEO 4550 (*Field Geology for Geological Engineers*). Geographic Information System (GIS) tools are integrated into one of the field exercises as well as its importance to future engineering practice.

GEO 5150 (*Geological Engineering Design*). The theory behind all the analysis and design aspects of the course are refreshed before introducing the students to the cutting-edge Slide and Settle3D software packages by RocScience for geotechnical engineering design and analysis.

GEO 5385 (*Introduction to Groundwater Modeling*). This course uses the state-of-the-art GMS (Groundwater Modeling System) which incorporates a number of stand physical (e.g., MODFLOW) and geochemical (e.g., FEMWATER) numerical models.

Educational objective #3:

*Graduates will strive to develop and maintain a professional environment that fosters honesty, integrity, and a strong engineering and work ethic.*

Related student outcome and course work:

f) *an understanding of professional and ethical responsibility.* Examples from courses include:

GEO 5150 (*Geological Engineering Design*). Case studies in ethics are a critical component of the course.

GEO 5390 (*Solute Transport and Subsurface Remediation*). Assignment #4 involves risk assessment based on Maximum Contaminant Levels as established by the EPA. Risk assessment is also a component of the course project.
CRITERION 4. CONTINUOUS IMPROVEMENT

A. Student Outcomes

Between 2009 and 2015, seven methodologies have been employed as mechanisms to continuously improve the geological engineering program. These methodologies are overseen and documented by the Chair of the Geological Engineering Committee.

A brief overview and example of methodologies I – III are provided here; a file folder with multiple examples of these methodologies will be provided to the program evaluator during the site visit. Methodologies IV – VII are described in summary detail here.

I. Course examinations and problems. This methodology for improvement has been a staple of the geological engineering program for decades. Specific course problem sets and exams are relatively easy to link to student outcomes (e.g., outcome A, application of basic math and science knowledge is relatively easy to demonstrate for quantitatively-oriented courses such as fluid dynamics and groundwater). An example is given in Figure 4A.1

II. Informal examination of students. This methodology was put in place following the last general review and involves the instructor establishing a metric for a particular student outcome, for instance achieving 80% correct response about a particular contemporary issue of importance to engineers (e.g., outcome j, a knowledge of contemporary). These examinations are not a part of the formal student grade and the students are not warned ahead of time that the assessment will be taking place. An example is given in Figure 4A.2

III. Student class memos. During preparation for the last general review (2009) the difficulty of quantitatively assessing certain student outcomes, particularly those that are difficult to quantify (outcomes f-j), was recognized. A new methodology for evaluating these so-called “soft” outcomes was begun in the fall, 2012 semester. Jewell started a dialogue with the Department of Civil and Environmental Engineering (CVEEN) to observe the manner in which this program evaluated these outcomes. CVEEN assesses these outcomes as a part of its senior design course (CVEEN 4910). Students write memos based on seminars on some of the "soft" topics associated with a specific outcome. These are graded assignments. Students are also assessed on their communication skills by the instructor team, faculty visitors, and external advisors. Every student is assessed and the reporting is completed following the class presentations on paper forms. Upon observing these procedures in action, similar exercises were folded into the geological engineering curriculum. An example is given in Figure 4A.3

IV. Student projects. Extended student projects are a critical feature of a number of courses in the curriculum, particularly the two capstone design courses (GEO 5150 and GEO 5390), the field methods course (GEO 4500), and the summer field course (GEO 4550). Extensive examples of student project work from these courses will be made available
during the site visit. Inasmuch as these reports are 50 or more pages long, a specific example is not provided here.

V. **Student exit interviews.** The chair of the Geology and Geophysics Department endeavors to conduct exit interviews with all graduating seniors (geological engineering or otherwise). The format of the resulting document is oriented toward assessing student outcomes and results are discussed below and is described in more detail in Criterion B above. A summary of exit interviews is given in Table 4A.2.

VI. **Interaction with other academic units.** Interaction with other engineering programs on the University of Utah campus as well as Salt Lake Community College (SLCC) was a new hallmark for instituting continuous improvement of outcomes during the 2009-2015 period. The tangible outcome of these interactions has been establishing a new Associate’s Degree in Geological Engineering at SLCC.

VII. **Communication, Leadership, Ethics, and Research (CLEAR) program.** One outcome of the 2009 general review of the geological engineering program was a recommendation from the program evaluator that we take advantage of the CLEAR program which has been in place in the College of Engineering for a number of years.
Figure 4A.1 Example of Methodology I used to assess Outcome a).
GEOLOGICAL ENGINEERING
COURSE LEVEL ASSESSMENT

COURSE NO: Geo 5350 – Fall 2010
COURSE TITLE: Groundwater
INSTRUCTOR: D. Kip Solomon, Ph. D., Professor

Program Outcomes addressed by this course:

Primary Outcome
a) an ability to apply knowledge of mathematics, science, and engineering

Secondary Outcome
c) an ability to design a system, component, or process to meet desired needs

Proficiency Levels:
Mastery: Ability to complete the assignment with no significant errors. 90 to 100 % credit received for exam or homework assignment

Good: Ability to complete assignment with no conceptual errors. Only small computational errors are allowed. 80 to 90 % credit received for exam or homework assignment.

Poor: Conceptual errors and possibly significant computational errors. Less than 80% credit received for exam or homework.

Proficiency Goal
Ninety percent of students achieving mastery level on exam question or assignment.

Assessment

The students (there were only 2 geological engineering student in the course) were given a flownet problem that evaluated outcome a (ability to apply knowledge of math, science, and engineering), and an aquifer testing problem that evaluated c (ability to design a system…). The problems are shown on the following pages.
**Outcome A**

Number of assessments: 2  
Range: 72-88%  
Number of scores > 90%: 0

Evaluation: Although 1 student was near the goal of 90%, the other was well below it, so the goal was not reached.

Remedial Plans:  
Additional homework problems were assigned that allowed students to practice flow nets and the computation of total flow. A flownet problem was included in the final exam with the following results.

Number of assessments: 2  
Range: 92% for both students  
Number of scores > 90%: 2

Evaluation: The goal was met.

**Outcome C**

Number of assessments: 2  
Range: 100% for both students  
Number of scores > 90%: 2

Evaluation: The goal was met.

Remedial Plans: None needed
MEMORANDUM

TO: Senior Engineer Dan Seely
FROM: [redacted], Junior engineer
SUBJECT: ENGINEERING IMPACT ON SOCIETY AND CONTINUING EDUCATION
DATE: April 7th, 2014

Although the solution to engineering problems always complex, at times the impact on society and the ability to minimize this impact on peoples everyday lives along with the planning of such projects may require more intricate planning. Understanding these impacts during the design portion of such solutions can help in relieving stress on the public and the perception the public has on construction projects.

The duration of construction is particularly important, this factor influences positive or negative perception with the public. When designing solutions to these engineering problems, it is important to never take shortcuts that might compromise the project only to save to time and money. Complete understanding of your engineering discipline will allow you to never make the mistake of compromising a design for the pure sake of shortening construction time, and therefore being able to put together a plan with the best solution and the most concise yet intricate completion ability.

The ability to continue learning after college is key with being able to achieve what was previously stated. Always knowing the most current and sophisticated information about your engineering discipline will allow you to create better design solutions, and with that perhaps better planning and management of completion. Staying current on such information will keep you relevant in the business world, and will build a good reputation and therefore create more opportunities to showcase design skills. This ability to continue learning is the most important factor in an engineer's life and career, lengthening a career or perhaps shortening the amount of years you work before retirement. More knowledge equals more power and therefore more money.
Table 4A.1. Calendar of dates for collecting documents that assess student outcomes.

<table>
<thead>
<tr>
<th>COURSE</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
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<td>GEO 5370/5690</td>
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<td>F-2010</td>
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</tbody>
</table>
Table 4A.2. Relationship between methodologies I - IV and student outcomes.

<table>
<thead>
<tr>
<th>COURSE</th>
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<th>B</th>
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<td>GEO 5390</td>
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<td>I, IV</td>
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Outcome assessment tools

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<table>
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<tbody>
<tr>
<td>I</td>
<td>Classroom exercises (given as a routine grading within a course)</td>
</tr>
<tr>
<td>II</td>
<td>Non-graded assessment (separate assessment with specific achievement level)</td>
</tr>
<tr>
<td>III</td>
<td>Memo/reflection (written response to class presentation or reading)</td>
</tr>
<tr>
<td>IV</td>
<td>Student projects</td>
</tr>
</tbody>
</table>
V. Exit interviews summary

Not all students avail themselves to the opportunity of an exit interview; between 2009-2015 six graduating students conducted formal exit interviews.

Figure 4A.4. Exit interview form used by the department chair for graduating students

<table>
<thead>
<tr>
<th>Skills, Abilities and Attributes</th>
<th>Chairperson's Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. An understanding of and ability to apply knowledge of:</td>
<td></td>
</tr>
<tr>
<td>1. mathematics (calculus and above)</td>
<td></td>
</tr>
<tr>
<td>2. physical sciences</td>
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<tr>
<td>3. engineering sciences</td>
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<td>4. computer science</td>
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<tr>
<td>5. earth and environmental science</td>
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<tr>
<td>6. field methods and camp experiences</td>
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<tr>
<td>B. An understanding of and ability to:</td>
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</tr>
<tr>
<td>1. design and conduct experiments</td>
<td></td>
</tr>
<tr>
<td>2. analyze and interpret data</td>
<td></td>
</tr>
<tr>
<td>3. design a system, component or process to meet a desired need</td>
<td></td>
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<tr>
<td>4. function on multi-disciplinary or cross-functional teams</td>
<td></td>
</tr>
<tr>
<td>5. identify, formulate and solve engineering problems</td>
<td></td>
</tr>
<tr>
<td>6. recognize professional and ethical responsibility</td>
<td></td>
</tr>
<tr>
<td>7. communicate orally: informal and prepared talks</td>
<td></td>
</tr>
<tr>
<td>8. communicate in writing: letters, technical reports</td>
<td></td>
</tr>
<tr>
<td>9. know the impact of engineering in a global/societal context</td>
<td></td>
</tr>
<tr>
<td>10. recognize the need to engage in life-long learning</td>
<td></td>
</tr>
<tr>
<td>11. know about contemporary issues</td>
<td></td>
</tr>
<tr>
<td>12. use techniques, skills and tools in engineering practice</td>
<td></td>
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</tbody>
</table>

Additional Comments concerning experiences in the department as a whole, comments concerning faculty and staff, and student advising.

13: What was the quality of student advising, including access to advisors and quality of advice?

14: If you have taken the FE exam, how well were you prepared by your course work and experience?

15: Would you please elaborate on the best and perhaps least favorable experience(s) during your undergraduate training.

The questions given above parallel student outcomes with the exception of splitting communication skills into oral and written components. One shortcoming of the exit interview was a lack of consistent words to address the skills, abilities, and attributes (portions A. and B.) of the questionnaire. By assigning a numerical score to words (i.e., excellent = 5, very good = 4, good =3, fair = 2, poor = 1), the students assessment of this portion of the survey could be assessed.
Table 4A.3. Summary of Student Exit Interviews (5 = excellent, 4 = very good, 3 = good, 2 = fair, 1 = poor

<table>
<thead>
<tr>
<th>A</th>
<th>An understanding of and ability to apply knowledge of:</th>
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<tbody>
<tr>
<td>1.</td>
<td>Mathematics (calculus and above)</td>
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<tr>
<td>2.</td>
<td>Physical sciences</td>
</tr>
<tr>
<td>3.</td>
<td>Engineering sciences</td>
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<tr>
<td>4.</td>
<td>Computer science</td>
</tr>
<tr>
<td>5.</td>
<td>Earth and environmental science</td>
</tr>
<tr>
<td>6.</td>
<td>Field methods and camp experience</td>
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</table>

<table>
<thead>
<tr>
<th>B</th>
<th>An understanding of and ability to:</th>
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</thead>
<tbody>
<tr>
<td>1.</td>
<td>Design and conduct experiments</td>
</tr>
<tr>
<td>2.</td>
<td>Analyze and interpret data</td>
</tr>
<tr>
<td>3.</td>
<td>Design a system, component, or process to meet a desired need</td>
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<tr>
<td>4.</td>
<td>Function on multi-disciplinary or cross functional teams</td>
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<tr>
<td>5.</td>
<td>Identify, formulate, and solve engineering problems</td>
</tr>
<tr>
<td>6.</td>
<td>Recognize professional and ethical responsibility</td>
</tr>
<tr>
<td>7.</td>
<td>Communicate orally – informal and prepared talks</td>
</tr>
<tr>
<td>8.</td>
<td>Communicate in writing – letters, technical reports, etc.</td>
</tr>
<tr>
<td>9.</td>
<td>Know about contemporary issues</td>
</tr>
<tr>
<td>10.</td>
<td>Recognize the need to engage in life-long learning</td>
</tr>
<tr>
<td>11.</td>
<td>Know about contemporary issues</td>
</tr>
<tr>
<td>12.</td>
<td>Use techniques, skills, and tools in engineering practice</td>
</tr>
</tbody>
</table>

VI. Interaction with other academic units

Between 2009-2015, efforts were made to improve the geological engineering program by observing the capstone design course in the University of Utah’s Department of Civil and Environmental Engineering and by joining the Program Advisory Committee (PAC) at Salt Lake Community College.

**Updated assessment mechanisms for Student Outcomes.** In an effort to improve assessment of so-called “soft” student outcomes (f through j), a member of the Geological Engineering Committee began attending CVEEN 4910 (“Professional Practice and Design”) during the Fall, 2012 semester. As a result of these observations, Methodology III described above was adopted for the geological engineering program.

**Membership in Program Advisory Committee (representatives from all engineering programs along the Wasatch Front).** Holly Moore, Associate Professor of Engineering at the Salt Lake Community College, convenes a semi-annual meeting of representatives from all engineering programs along the Wasatch Front to discuss common problems and approaches to teaching and advising students. For instance, the October 30, 2014 meeting included the agenda given below in additional to a roundtable discussion of the best methods to teach fundamental computer programming.
Table 4A.4. Agenda for the October, 2014 Program Advisory Committee (Salt Lake Community College)

October, 2014 Program Advisory Committee Agenda

· Progress on proposed new APE degrees at SLCC in Metallurgical Engineering, Mining Engineering and Geological Engineering
· Reintroduction of Manufacturing, MEEN 2650, to the Mechanical Engineering APE
· Board of Regents approval of the SLCC certificate programs in Nanotechnology and Microscopy
· Curriculum changes in 4 year programs we need to be aware of / respond to
· Transfer issues/ problems – are there any mismatches in content etc that SLCC needs to address
· There are a growing number of students who are ‘circulating’ between Weber State, UVU, and SLCC before going on to 4 year programs – are we serving their needs – are there issues we need to address?
· Upcoming transfer events – how can we make these more productive?

VII. Communication, Leadership, Ethics, and Research (CLEAR) program

Following suggestions from the 2009 geological engineering program evaluator, the CLEAR program was employed in the two design courses (GEO 5150 and GEO 5390) during the spring, 2011 semester. Neither instructor was pleased with the results. One instructor’s evaluation was as follows:

“To summarize the CLEAR process: it didn't provide useful critical feedback for written communication beyond what the instructor and peer reviews provided. The CLEAR personnel were either operating at a level that wasn't practical for student needs (given their schedules) or simply weren't engaged.”

As a result, the CLEAR program is no longer employed in the geological engineering program.
Summary. On the basis of the data collected for the methodologies presented above, the geological engineering faculty was canvased to determine the extent to which program outcomes were being achieved. Methodologies VI and VII are not represented in this summary.

Table 4A.5 Summary of extent to which student outcomes are being achieved.

<table>
<thead>
<tr>
<th>Student Outcome</th>
<th>Level of Achievement</th>
<th>Supporting Evidence (methodology designation)</th>
<th>Possible Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. ability to apply knowledge of mathematics, science, and engineering</td>
<td>Excellent</td>
<td>Course examination, problems, and none-graded assessments (I, II)</td>
<td>None</td>
</tr>
<tr>
<td>B. ability to apply knowledge of mathematics, science, and engineering</td>
<td>Excellent</td>
<td>Course examination, problems, and none-graded assessments (I, II)</td>
<td>None</td>
</tr>
<tr>
<td>C. ability to design a system, component, or process to meet desired needs</td>
<td>Excellent</td>
<td>Course examination, problems, and none-graded assessments (I, II); student projects (IV)</td>
<td>None</td>
</tr>
<tr>
<td>D. ability to function on multi-disciplinary teams</td>
<td>Excellent</td>
<td>Course examination, problems; none-graded assessments; student projects (I, II, IV)</td>
<td>None</td>
</tr>
<tr>
<td>E. ability to identify, formulate, and solve engineering problems</td>
<td>Excellent</td>
<td>Course examination, problems; none-graded assessments (I, II)</td>
<td>None</td>
</tr>
<tr>
<td>F. understanding of professional and ethical responsibility</td>
<td>Good</td>
<td>Course examination, problems; none-graded assessments; student memos (I, II, V)</td>
<td>Exercises in additional classes; student memo methodology still in its infancy</td>
</tr>
<tr>
<td>G. ability to communicate effectively</td>
<td>Good</td>
<td>Student projects; exit interviews (IV, V)</td>
<td>While all other metrics are favorable, exit interviews indicate students do not perceive it the same way</td>
</tr>
<tr>
<td>H. broad education necessary to understand the impact of engineering solutions in a global and societal context</td>
<td>Fair</td>
<td>None-graded assessments; student memos (II, V)</td>
<td>Emphasis in the introductory and design classes; student memo methodology in its infancy</td>
</tr>
</tbody>
</table>
I. recognition of the need for, and an ability to engage in life-long learning

<table>
<thead>
<tr>
<th>Quality</th>
<th>Exit interviews (V)</th>
<th>More frequent informal meetings with majors as a group; emphasis in the introductory and design classes.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fair</td>
<td>Exit interviews (V) seem to indicate students are not aware of the importance of continuing education</td>
<td>More frequent informal meetings with majors as a group; emphasis in the introductory and design classes.</td>
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</tbody>
</table>

J. knowledge of contemporary issues

<table>
<thead>
<tr>
<th>Quality</th>
<th>Exit interviews (I, II, V)</th>
<th>Emphasis in the introductory and design classes.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>None-graded assessments; student memos; exit interviews (II, III, V)</td>
<td>Emphasis in the introductory and design classes.</td>
</tr>
</tbody>
</table>

K. ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

<table>
<thead>
<tr>
<th>Quality</th>
<th>Exit interviews (I, II, V)</th>
<th>Emphasis in the introductory and design classes.</th>
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</thead>
<tbody>
<tr>
<td>Good</td>
<td>Course examination, problems; none-graded assessments; exit interviews (I, II, V)</td>
<td>While all other metrics seem positive, exit interviews would indicate students do not perceive it the same way</td>
</tr>
</tbody>
</table>

B. Continuous Improvement

In addition to continuous improvement in assessing student outcomes, the geological engineering faculty has been diligent in trying to improve the overall curriculum particularly within the context of the program constituencies. In general, the faculty believed the curriculum to be solid although efforts were made to make total credit hours in the program in line with other engineering programs at the University of Utah (e.g., Civil and Environmental Engineering – 127 credits). The following changes were enacted during the period of 2009-2015 mostly as a result of discussions during constituency meetings.

Table 4B. 1 Changes in geological engineering curriculum between 2009-2015

<table>
<thead>
<tr>
<th>Action</th>
<th>Effective year</th>
<th>Rationale for change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase credit hours for GEO 5560</td>
<td>2013</td>
<td>Change of instructors</td>
</tr>
<tr>
<td>Reduce credit hours for GEO 3400</td>
<td>2013</td>
<td>Change of instructors</td>
</tr>
<tr>
<td>Dropped MGEN 5040 (“Engineering Design”) from curriculum</td>
<td>2014</td>
<td>Student feedback; constituency meetings. Desire to decrease total number of program credits.</td>
</tr>
<tr>
<td>Dropped GEO 5370 (“Contaminant Partitioning for Scientists and Engineering” from curriculum</td>
<td>2014</td>
<td>Student feedback; constituency meetings. Desire to decrease total number of program credits.</td>
</tr>
</tbody>
</table>
C. Additional Information

Associates Degree in Geological Engineering (2-year).

The low numbers of majors in the program has been a chronic concern for both geological engineering faculty as well as the higher levels of departmental and college administration. An Associates Degree (2 year) in Geological Engineering was implemented at Salt Lake Community College during the 2013-2014 academic year. It is hoped that this effort will increase the number of students who might not otherwise consider geological engineering as a major when they transfer from this important 2-year institution. Courses for the associates degree closely track those of years 1 and 2 of the B.S. degree (Figure 1F.1) and are listed in the table on articulations (Table 1C.1).

Combined BS/MS degree in geological engineering

Various departments on the University of Utah College of Engineering have offered a combined BS/MS degree for some years. The philosophy behind this degree is to allow well-qualified students begin work an advanced degree once they had achieved the 122 credit minimum required for the standard BS degree.

Geological engineering majors had long expressed interest in having a similar option in our own college and after putting the appropriate paperwork through the University administration, the combined BS/MS degree in geological engineering was approved. The decision by the Geological Engineering Committee to lower total credits in the GE degree to 126 semester hours has made this particular option somewhat less desirable. To date, only one student has taken advantage of the BS/MS option.
Figure 4C. 1. Description of particulars for the combined BS/MS degree in geological engineering.

College of Mines and Earth Sciences

Proposal for combined B.S. / M.S. Program
In Geological Engineering

To: Graduate Affairs Committee; Undergraduate Affairs Committee
From: Geological Engineering Committee (Paul Jewell, Bill Johnson, Kip Solomon, Aurelian Trandafer)

Rationale
As a premier research institution and technological leader in the mountain west, the University of Utah offers unique educational research opportunities for undergraduate students. Students are given the opportunity to participate in ongoing research at a variety of levels, including undergraduate research and honors projects, participation in graduate student and faculty research projects and in guest lectures delivered by leaders in the field and discussions of cutting edge research.

Background
For students interested in a BS degree in geological engineering, the current degree requirements (134 credit hours) can seem daunting and are no doubt one cause of the small numbers of undergraduate majors. In recent years, the MS degree has become highly desirable for practicing engineers. For undergraduate students interested in pursuit of research and an advanced degree, a combined BS/MS degree program intended to foster undergraduate research and to accelerate progress toward the MS degree is thus timely and attractive.

The combined program described below is designed to be completed by students in five years and to culminate with the simultaneous conferral of the Bachelor of Science and Master of Science degrees. Students in the combined program begin their research early and complete advanced level courses during the senior year. These activities can accelerate completion of the combined program by a full year relative to enrollment in sequential BS – MS programs. Students are encouraged to begin research in the summer following their junior year. The following minimum requirements must be met universally:

1) Students must complete a minimum of 152 semester credit hours of qualified studies. A minimum of 30 semester credit hours must meet the MS requirements of the University of Utah Graduate School, the College of Mines and Earth Sciences, and the Department of Geology and Geophysics. A minimum of 122 semester credit hours must meet the B.S. requirements of the geological engineering program.

2) Undergraduate students must apply to the program through a participating College of Mines and Earth Sciences department by April 1st of the Junior year. Recommendations for admission are made by the Department of Geology and Geophysics to the Graduate School by June 1st each year. Entrance criteria for the combined BS/MS program are consistent with criteria for the traditional MS program(s).

3) Admitted students must submit a BS/ MS program of study to the department within one semester after admission.
4) Transfer from undergraduate to graduate status occurs after completion of 122 semester credit hours of qualified studies.
5) The BS and MS degrees are conferred simultaneously following completion of the program.
6) Students wishing to exit the combined program can apply qualified coursework toward the traditional BS and MS degree requirements without penalty.
7) No student will be awarded a separate MS degree without satisfying all requirements for the BS degree.

Procedures

1. Student will apply to BS/MS program at end of Junior year. This application is processed and decisions made at the department level. Consistent with University policy, entering students must have at least a 3.0 cumulative GPA.

2. Students must be enrolled in the geological engineering program at the time of applying for the BS/MS degree option.

3. The entering student will select an advisory committee and prepare a program of study for completion of the BS and MS degree during first semester in the combined program.

4. The student will apply for graduate status during the semester in which 122 credit hours are completed. Students will follow the regular University of Utah Graduate School application process. All university requirements for graduate admissions must be met except posting of undergraduate degree. (Note: On the referral sheet that the department returns to graduate admissions, the department will note that the student has been accepted to the combined BS/MS program. Graduate Admissions will then approve admission without the BS completed.)

5. Following admission, a supervisory committee will be established within the department during the first semester of work toward the combined degree.

6. A mid-program review will be conducted by the supervisory committee after 2 semesters in the program.

7. Degrees will be awarded when all work is completed. A Master's degree will not be awarded under this program if all requirements for the BS are not completed.
## CRITERION 5. CURRICULUM

### A. Program Curriculum

**Table 5-1A. Curriculum**

Name of Program: Geological Engineering

<table>
<thead>
<tr>
<th>Course (Department, Number, Title)</th>
<th>Indicate Whether Course is Required, Elective or a Selected Elective by an R, an E or an SE.¹</th>
<th>Subject Area (Credit Hours)</th>
<th>Engineering Topics Check if Contains Significant Design (✓)</th>
<th>General Education</th>
<th>Other</th>
<th>Last Two Terms the Course was Offered: Year and, Semester, or Quarter</th>
<th>Maximum Section Enrollment for the Last Two Terms the Course was Offered²</th>
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<tbody>
<tr>
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</table>

**TOTALS-ABET BASIC-LEVEL REQUIREMENTS**

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<th>Required</th>
<th>Year(s)</th>
<th>Notes</th>
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<tr>
<td>MG EN 5150 Mechanics of Materials</td>
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**OVERALL TOTAL CREDIT HOURS FOR COMPLETION OF THE PROGRAM**

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<th>Hours</th>
<th>Percentage</th>
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<td>48 Hours</td>
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<td>Minimum Percentage</td>
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<td>34.5%</td>
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**Minimum Semester Credit Hours**

Minimum: 32 Hours

Minimum Percentage:

- 25%
- 34.5%
- 19.0%
1. **Required** courses are required of all students in the program, **elective** courses (often referred to as open or free electives) are optional for students, and **selected elective** courses are those for which students must take one or more courses from a specified group.

2. For courses that include multiple elements (lecture, laboratory, recitation, etc.), indicate the maximum enrollment in each element. For selected elective courses, indicate the maximum enrollment for each option.

Note: instructional materials and student work verifying compliance with ABET criteria for the categories indicated above will be required during the campus visit.
As shown in Tables 5A.2 and Figure 5A.1, the program progresses from basic math and science, to fundamental engineering courses (statics, strength of materials, soil and rock mechanics), core geology courses, and finally culminating in the two major design courses (GEO 5150 and GEO 5390) as well as the capstone field course (GEO 4550). The design courses are meant to undergird Program Educational Objective #1. Educational Objectives #2 and #3 are met by various exercises and lectures in the two design courses plus GEO 3075 (“Introduction to Geological Engineering”).

Table 5A.2 Curriculum alignment with the program educational objectives

<table>
<thead>
<tr>
<th>Program Educational Objectives</th>
<th>Relevant Program Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Graduates will be capable of utilizing their backgrounds in engineering and earth science to provide solutions to engineering problems within the context of the natural world. Areas of geological engineering practice might include fluid flow and contaminant transport in the subsurface; geo-mechanics (i.e., the behavior of earth materials), geo-engineering (i.e., design with earth materials); and discovery, development, and utilization of energy resources.</td>
<td>MATH 1210, 1220, 2210, 2250&lt;br&gt;PHYS 2210, 2219, 2220&lt;br&gt;CHEM 1210, 1215, 1220, 1225&lt;br&gt;CVEEN 2210, 3310, 5305&lt;br&gt;MGEN 5150, 5160&lt;br&gt;GEO 3075, 5350, 5360, 5385, 5390</td>
</tr>
<tr>
<td>2) If employed as an engineer, the graduate will aspire to obtain professional engineer registration, and will be active in professional societies and continuing education activities that work to improve their professional stature.</td>
<td>GEO 3075, 5150</td>
</tr>
<tr>
<td>3) The graduates will strive to achieve a professional environment that fosters honesty, integrity, and a strong engineering and work ethic.</td>
<td>GEO 5150, 5390</td>
</tr>
</tbody>
</table>

Table 5A.2. Curriculum, associated prerequisite structure, and support for the attainment of the student outcomes

<table>
<thead>
<tr>
<th>Course</th>
<th>Prerequisites</th>
<th>Student outcome(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 1210 General Chemistry I</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHEM 1215 General Chemistry Lab I</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATH 1210 Calculus I</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHEM 1220 General Chemistry II</td>
<td>CHEM 1210</td>
<td></td>
</tr>
<tr>
<td>CHEM 1225 General Chemistry Lab II</td>
<td>CHEM 1215</td>
<td></td>
</tr>
<tr>
<td>MATH 1220 Calculus II</td>
<td>MATH 1210</td>
<td></td>
</tr>
<tr>
<td>CVEEN 2110 Statics</td>
<td>MATH 1210</td>
<td></td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Name</td>
<td>Prerequisites</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>-----------------------------------------------------</td>
</tr>
<tr>
<td>GEO 3075</td>
<td>Introduction to Geological Engineering</td>
<td>MATH 1220, CHEM 1220 A, C, H, I, J</td>
</tr>
<tr>
<td>GEO 3070</td>
<td>Earth Materials for Engineers</td>
<td></td>
</tr>
<tr>
<td>MATH 2210</td>
<td>Calculus III</td>
<td>MATH 1220</td>
</tr>
<tr>
<td>PHYS 2210</td>
<td>Physics for Scientists and Engineers I</td>
<td>MATH 1210</td>
</tr>
<tr>
<td>PHYS 2219</td>
<td>Physics Lab for Scientists and Engineers I</td>
<td>PHYS 2210</td>
</tr>
<tr>
<td>MATH 2250</td>
<td>ODE's and Linear Algebra</td>
<td>MATH 2210</td>
</tr>
<tr>
<td>MG EN 1050</td>
<td>Technical Communications (CAD)</td>
<td></td>
</tr>
<tr>
<td>MG EN 5150</td>
<td>Mechanics of Materials</td>
<td>MATH 2210, PHYS 2220 CVEEN 2010</td>
</tr>
<tr>
<td>GEO 3090</td>
<td>Earth Materials II</td>
<td>GEO 3070, MATH 1210</td>
</tr>
<tr>
<td>PHYS 2220</td>
<td>Physics for Scientists and Engineers II</td>
<td>PHYS 2210</td>
</tr>
<tr>
<td>GEO 5760</td>
<td>Stratigraphy and Sedimentary Processes</td>
<td>GEO 3090 E</td>
</tr>
<tr>
<td>MG EN 2400</td>
<td>Surveying and Global Positioning</td>
<td></td>
</tr>
<tr>
<td>GEO 3400</td>
<td>Computational and Field Methods in Applied Geology</td>
<td>I, K</td>
</tr>
<tr>
<td>MET E 3070</td>
<td>Statistical Methods for Earth Scientists and Engineers</td>
<td></td>
</tr>
<tr>
<td>CVEEN 3310</td>
<td>Geotechnical Engineering I</td>
<td>MGEN 5150 A, B, E</td>
</tr>
<tr>
<td>GEO 3060</td>
<td>Structural Geology and Tectonics</td>
<td>MATH 1060 A</td>
</tr>
<tr>
<td>GEO 3010</td>
<td>Geophysics</td>
<td>MATH 1210 K</td>
</tr>
<tr>
<td>GEO 4500</td>
<td>Field Methods</td>
<td>GEO 3060, 5760 D</td>
</tr>
<tr>
<td>GEO 4550</td>
<td>Field Geology for Engineers</td>
<td>GEO 3075, 5350 CVEEN 3310 B, D, G, K</td>
</tr>
<tr>
<td>GEO 5350</td>
<td>Groundwater</td>
<td></td>
</tr>
<tr>
<td>GEO 5560</td>
<td>Numerical Methods</td>
<td>GEO 3400 A, F, H</td>
</tr>
<tr>
<td>CVEEN 5305</td>
<td>Introduction to Foundations</td>
<td>MATH 2250, CVEEN 3310 C</td>
</tr>
<tr>
<td>MGEN 5160</td>
<td>Rock Mechanics</td>
<td>MGEN 5150</td>
</tr>
<tr>
<td>GEO 5360</td>
<td>Fluid Dynamics of Earth Materials</td>
<td>MATH 2250, CVEEN 2110 A, B</td>
</tr>
<tr>
<td>GEO 5385</td>
<td>Introduction to Groundwater Modeling</td>
<td>GEO 5350 B, K</td>
</tr>
<tr>
<td>GEO 5390</td>
<td>Solute Transport and Subsurface Remediation</td>
<td>GEO 3090, 3400, 5350, 5360 B, D, E, F, G, H, J</td>
</tr>
</tbody>
</table>
As shown in Table 5A.1, the program requirements in terms of hours and depth of study for math and basic sciences, engineering topics, and general education are covered in terms of the existing curriculum. Figure 5A.2 shows the allowable courses for the one technical elective within the curriculum.
Figure 5A.2. Recommended electives within the geological engineering curriculum.

Recommended Electives
Bachelor of Science in Geological Engineering
Department of Geology & Geophysics, University of Utah

Geological Engineering undergraduate majors have a variety of career paths open to them, and specialized electives can make new graduates more attractive to potential employers. Below are some recommended elective courses tailored for various industry career paths:

<table>
<thead>
<tr>
<th>Environmental</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEO 5370: Environmental Contaminants (3 CH) Prerequisite: CHEM 1210, 1220 or consent of instructor</td>
</tr>
<tr>
<td>GEO 5660: Geochemistry (3 CH) Prerequisite: GEO 1110 and CHEM 1220</td>
</tr>
<tr>
<td>GEO 5920 (W. Johnson): Ecuador study abroad (7 CH) Prerequisite: GEO 5920 (W. Johnson): Aquaeous Geochemistry (2 CH) Prerequisite:</td>
</tr>
<tr>
<td>GEO 5920 (L. Stright): Reservoir Characterization and Modeling (3 CH) Prerequisite: GEO 5760</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Geotech and hazards</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEO 5170: Geohazards and Engineering Geomorphology (3 CH) Prerequisite: GEO 3070, 3080, PHYS 2210</td>
</tr>
<tr>
<td>GEO 5330: Earthquake Seismology and Hazard Assessment (3 CH) Prerequisite: GEO 5210, 5320, MATH 3150</td>
</tr>
<tr>
<td>GEO 5565: Digital Mapping and GIS in Geoscience (2 CH) Prerequisite: GEO 1110 and 1115</td>
</tr>
<tr>
<td>GEO 5370: Environmental Contaminants (3 CH) Prerequisite: CHEM 1210, 1220 or consent of instructor</td>
</tr>
<tr>
<td>GEO 5320: Signal Processing (3 CH) Prerequisite: linear algebra and PDE's</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Oil and gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEO 5510: Introduction to Petroleum Systems: PICP 1a (1.5 CH) Prerequisite: GEO 3060 and GEO 5760</td>
</tr>
<tr>
<td>GEO 5510: Introduction to Petroleum Systems: PICP 1a (1.5 CH) Prerequisite: GEO 3060 and GEO 5760</td>
</tr>
<tr>
<td>GEO 5525: Petrophysics and Well Logging: PICP 2a (1.5 CH) Prerequisite: GEO 5520/5520</td>
</tr>
<tr>
<td>GEO 5530: Geologic Interpretation of Seismic Reflection Data: PICP 2b (1.5 CH) Prereq: GEO 5525/5525</td>
</tr>
<tr>
<td>GEO 5920 (L. Stright): Applied Geostatistics (3 CH) Rec Prerequisite: linear algebra</td>
</tr>
<tr>
<td>GEO 5920 (L. Stright): Reservoir Characterization and Modeling (3 CH) Prerequisite: GEO 5760</td>
</tr>
</tbody>
</table>

Fundamentals of Engineering Exam Prep
College of Engineering review sessions and materials, plus general FE exam info: http://www.coe.utah.edu/fee

revised 9/14
**Major design experiences**

The program curriculum logically culminates in a double design experience in the context of geo-mechanical and geo-engineering design (GEO 5150; Geological Engineering Design), and in the context of groundwater remediation (GEO 5390; Solute Transport and Subsurface Remediation). The design experiences are based on the knowledge and skills acquired in earlier course work and incorporate engineering standards and realistic constraints that include most of the following considerations: economic; environmental; sustainability; manufacturability; ethical; health and safety; social; and political.

As for GEO 5150, its aim is to provide the students with a comprehensive design experience in the field of geo-engineering. The coursework involves the completion of one general project, with different aspects of design. The students will have to use their knowledge in geotechnical engineering (CVEEN 3310, GEO 3075), strength of materials (CVEEN 2140 or MGEN 5150), groundwater (GEO 5350), and statics (CVEEN 2110) in order to successfully accomplish the design objectives.

The project involves a highway embankment for a proposed railroad overpass bridge approach. The design approach guidelines follow current recommendations set forth by the Utah Department of Transportation documentation. The design atmosphere uses a real-world Design-Build style, where the students work as a team and the interaction between the students and the instructor is high. The students are first tasked with designing a site investigation program, which includes choosing a drilling and sampling methods appropriate for the subsurface conditions (soft soil site). The students use their recommended site investigation proposal to also put together a laboratory testing program in an effort to aid in the acquisition of engineering design and analysis parameters. The design problem involves hands-on laboratory work which includes tests to determine index properties, compaction, consolidation, long-term settlement, hydraulic conductivity, and strength. The data obtained from the hands-on laboratory testing are combined with real-world data from a local site which includes a comprehensive laboratory testing data set, boring logs, and CPT soundings. The students use the extensive data package to sharpen their data interpretation skills as well as employing their engineering judgement, some using this skill for the first time. The complete data set is compressed into several site characterization plots where the engineering parameters and subsurface layers are displayed in an easily referenced manner. The theory behind all the analysis and design aspects are refreshed before introducing the students to both Slide and Settle3D software packages by RocScience for geotechnical engineering design and analysis. The students are tasked with designing the side slopes of the embankment to meet pre-defined factors of safety under short-term, long-term, and pseudo-seismic loading conditions using limit equilibrium methods. Due to the soft soil conditions at the design site, the students are tasked with designing an embankment surcharging program to reduce long-term secondary settlement, which has pre-defined limits. Since the design project involves a Design-Build style, the project has a limited time window for the investigation, laboratory testing, data interpretation, site characterization, analysis, design, and construction. To meet this demanding time schedule, the students are tasked with designing a pre-fabricated vertical drain array in decrease the settlement time. Each step of the design process is summarized in memorandum style submittals, which are combined at the end of the semester into a comprehensive technical design report. The importance of the responsibility of professional engineering judgement, the importance of various engineering solutions in a global and societal context, and engineering ethics are stressed throughout the semester and are
included in several homework assignment submittals. Each student is expected to perform his/her own work and produce individual homework and final design reports. The students work together in groups near the end of the semester to produce a final presentation summarizing the design project, hurdles, and engineering recommendations for the project.

As for GEO 5390, “Solute Transport and Subsurface Remediation”, the context of the course is characterization of a hypothetical contaminated aquifer and the design of a viable remediation system for the contaminated site. The major effort in the course is a project which is initiated during the first week of the course, and which is developed over the course of the term in weekly assignments which contribute to site characterization and remedial design. The final report is a team compilation and distillation of individual efforts accumulated over the semester.

Students perform site characterization that draws upon their cumulative knowledge gained in courses such as: physical geology, mineralogy, petrology, structural geology, stratigraphy, field geology, hydrology, groundwater, and environmental geochemistry. They then design a remediation system that meets regulatory needs (e.g. maximum contaminant levels for groundwater, risk-based contaminant levels for soil), based on engineering design equations derived from principles learned in fundamental engineering courses such as statics, fluid mechanics, dynamics, strength of materials, groundwater, and environmental organic chemistry.

Since there are many alternative characterization and remediation strategies, the problem is highly open-ended, and the students must make informed defensible simplifying decisions regarding, for example, distribution of contaminants at the site, and viability of various remediation technologies at the site, in order to move forward with their remedial strategy. The site characterization is performed from both ends simultaneously by a mock investigation that is governed by a limited budget, and by forward numerical modeling of groundwater flow and contaminant transport from potential contamination sources. A co-requisite course (Groundwater Modeling) teaches the skills required to use a state of the art groundwater flow and contaminant transport and reaction model (GMS, Groundwater Modeling System, EMSI, Inc.) in a networked computer laboratory on campus.

The remedial design consists of five to six components related to interim control of contamination, remediation of the unsaturated zones, and remediation of the saturated zone at the site, each requiring different engineering design considerations. Where engineering design equations are limited or lacking (e.g. air sparging, surfactant enhanced aquifer remediation, and bioremediation), a combination of informed defensible simplifying assumptions, scientific considerations, available engineering design equations, and numerical modeling are used. Each remediation technology employed must be evaluated in terms of short and long term reliability, estimated cost, and acceptability to regulators as well as the public relative to other candidate remediation technologies.

Material available to program evaluator during site visit will include assignments and exams from the highest, median, and lowest grades from a given assignment or exam.

Course Syllabi

Course syllabi for the program are provided in Appendix A
**CRITERION 6. FACULTY**

**A. Faculty Qualifications**

There are four full-time and one adjunct faculty fully committed to the Geological Engineering program in the Department of Geology and Geophysics: Dr. William Johnson, Dr. D. Kip Solomon, Dr. Jeffrey Moore, Dr. Paul Jewell, and Mr. Daniel Seely. An additional full-time faculty member with degrees and background in geological engineering, Dr. Lisa Stright, has participated in deliberations of the Geological Engineering Committee and constituency meetings but to date has not taught courses in the geological engineering program.

The five full-time faculty members are funded at 1.00 FTE and all engage in research (as is expected in a Research I University). Of the six faculty members, five have geological engineering or civil engineering degrees (Johnson, Solomon, Moore, Stright, and Seely) and the sixth (Jewell) has the equivalent of a Ph.D. in geological engineering degree (took appropriate engineering courses) but Princeton University does not award geological engineering doctorates. Mr. Seely is trained as a geological engineer and is a licensed professional engineer.

All five full-time faculty members teach and conduct research in geological engineering, and all participate in the management of the geological engineering degree program. Dr. Johnson’s research activities include research on microbial transport engineering for the purpose of enhanced in situ contaminant remediation, and contaminant remediation research. Dr. Solomon’s research includes examination of heavy metal plume mitigation in the Salt Lake Valley aquifers and hydrologic engineering (water budget) problems. Dr. Moore’s research is centered on the mechanics of landforms, landslides, and slope stabilities. Dr. Jewell works on surface water problems in the Bonneville Basin, application of LiDAR technologies to surface processes, and on pit lakes contamination management at mining sites. Dr. Stright is a petroleum engineer and specializes in subsurface characterization of hydrocarbon reservoirs.

Allied engineering faculty members in other departments also contribute to the geological engineering program. These faculty members (Drs. Bartlett, Lawton, McCarter, Rajamani) teach courses that are required in the geological engineering program curriculum, and Dr. Bartlett and McCarter take part in program assessment (e.g., constituency reviews). Their contributions are significant in terms of teaching courses our geological engineering majors take, meeting with our geological engineering advisory board, providing input into curriculum requirements, as well as serving in roles of student advising and encouraging career development. Collectively these faculty clearly contribute significant time and serve as a resource that strengthens our program.

Like all faculty at research universities, the geological engineering faculty are expected to commit significant amounts of time to maintaining a quality research program in addition to teaching and university service obligations, such as serving on the Geological Engineering Committee. The breakdown of faculty time given in Table 6-1 is probably typical of Research I institutions similar to the University of Utah.
B. Faculty Workload

Faculty workload is summarized in Table 6-2. As a Research I university, tenure-line faculty are expected to maintain a vigorous research program that is balanced by teaching and service to the department and university. A large fraction of this service is devoted to overseeing the geological engineering program.
### Table 6-1. Faculty Qualifications

#### Name of Program

<table>
<thead>
<tr>
<th>Faculty Name</th>
<th>Highest Degree Earned- Field and Year</th>
<th>Rank</th>
<th>Type of Academic Appointment</th>
<th>Years of Experience</th>
<th>Level of Activity&lt;sup&gt;4&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. Kip Solomon</td>
<td>Ph.D.</td>
<td>P</td>
<td>T</td>
<td>FT</td>
<td>6</td>
</tr>
<tr>
<td>Dr. William Johnson</td>
<td>Ph.D.</td>
<td>P</td>
<td>T</td>
<td>FT</td>
<td>5</td>
</tr>
<tr>
<td>Dr. Paul Jewell</td>
<td>Ph.D.</td>
<td>P</td>
<td>T</td>
<td>FT</td>
<td>4</td>
</tr>
<tr>
<td>Dr. Jeffrey Moore</td>
<td>Ph.D.</td>
<td>AST</td>
<td>TT</td>
<td>FT</td>
<td>3</td>
</tr>
<tr>
<td>Dr. Lisa Stright</td>
<td>Ph.D.</td>
<td>AST</td>
<td>TT</td>
<td>FT</td>
<td>3</td>
</tr>
<tr>
<td>Mr. Daniel Seely</td>
<td>M.S.</td>
<td>A</td>
<td>NTT</td>
<td>PT</td>
<td>5</td>
</tr>
<tr>
<td>Dr. Steven Bartlett</td>
<td>Ph.D.</td>
<td>P</td>
<td>T</td>
<td>FT</td>
<td>15</td>
</tr>
<tr>
<td>Dr. Evert Lawton</td>
<td>Ph.D.</td>
<td>P</td>
<td>T</td>
<td>FT</td>
<td>7</td>
</tr>
<tr>
<td>Dr. Kim McCarter</td>
<td>Ph.D.</td>
<td>P</td>
<td>T</td>
<td>FT</td>
<td>11</td>
</tr>
<tr>
<td>Dr. Michael Nelson</td>
<td>Ph.D.</td>
<td>P</td>
<td>T</td>
<td>FT</td>
<td></td>
</tr>
</tbody>
</table>

**Instructions:** Complete table for each member of the faculty in the program. Add additional rows or use additional sheets if necessary. Updated information is to be provided at the time of the visit.

1. **Code:** P = Professor  ASC = Associate Professor  AST = Assistant Professor  I = Instructor  A = Adjunct  O = Other
2. **Code:** TT = Tenure Track  T = Tenured  NTT = Non Tenure Track
3. **At the institution**
4. The level of activity, high, medium or low, should reflect an average over the year prior to the visit plus the two previous years.
<table>
<thead>
<tr>
<th>Faculty Member (name)</th>
<th>PT or FT</th>
<th>Classes Taught (Course No./Credit Hrs.) Term and Year</th>
<th>Program Activity Distribution</th>
<th>% of Time Devoted to the Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. Kip Solomon</td>
<td>FT</td>
<td>GEO 5350, Fall 2014, 3 credits GEO 5385, Spring 2015, 1 credit</td>
<td>40% 40% 20%</td>
<td>100</td>
</tr>
<tr>
<td>Dr. William Johnson</td>
<td>FT</td>
<td>GEO 5390, Spring 2015, 3 credits GEO 5560, Fall 2014, 3 credits</td>
<td>40% 40% 20%</td>
<td>100</td>
</tr>
<tr>
<td>Dr. Paul Jewell</td>
<td>FT</td>
<td>GEO 3400, Fall 2014, 2 credits GEO 4550, Summer 2015, 4 credits</td>
<td>40% 40% 20%</td>
<td>100</td>
</tr>
<tr>
<td>Dr. Jeffrey Moore</td>
<td>FT</td>
<td>GEO 3750, Fall 2014, 2 credits GEO 4550, Summer 2015, 4 credits</td>
<td>40% 50% 10%</td>
<td>100</td>
</tr>
<tr>
<td>Dr. Lisa Stright</td>
<td>FT</td>
<td>GEO 5150, Spring 2015, 4 credits</td>
<td>40% 50% 10%</td>
<td>10</td>
</tr>
<tr>
<td>Mr. Daniel Seely</td>
<td>PT</td>
<td>CVEEN 3310, Spring 2015, 3 credits</td>
<td>100%</td>
<td>100</td>
</tr>
<tr>
<td>Dr. Steven Bartlett</td>
<td>FT</td>
<td>CVEEN 3310, Spring 2015, 3 credits</td>
<td>40% 40% 20%</td>
<td>5</td>
</tr>
<tr>
<td>Dr. Evert Lawton</td>
<td>FT</td>
<td>CVEEN 5305, Fall 2014, 3 credits</td>
<td>40% 40% 20%</td>
<td>5</td>
</tr>
<tr>
<td>Dr. Kim McCarter</td>
<td>FT</td>
<td>MG EN 2400, Fall 2014, Summer 2015, 3 credits</td>
<td>40% 40% 20%</td>
<td>5</td>
</tr>
<tr>
<td>Dr. Raj Rajamani</td>
<td>FT</td>
<td>MET EN 3070, Fall 2014, 3 credits</td>
<td>40% 40% 20%</td>
<td>5</td>
</tr>
</tbody>
</table>

1. FT = Full Time Faculty or PT = Part Time Faculty, at the institution
2. For the academic year for which the Self-Study Report is being prepared.
3. Program activity distribution should be in percent of effort in the program and should total 100%.
4. Indicate sabbatical leave, etc., under "Other."
5. Out of the total time employed at the institution.
C. Faculty Size

As mentioned above, faculty size is sufficient to provide generous support to the program. Given the previous and current numbers of geological engineering majors (typically ~20 or less), our five dedicated core geological engineering faculty are more than sufficient in number to accommodate the student-faculty interaction and to handle advising and counseling, service activities, professional development, and practical industry interaction as required by Criterion 5.

Other faculty in the Department of Geology and Geophysics provide additional support of the geological engineering program through teaching required courses in the geological engineering curriculum, as validated by the statement in the Criterion 5: (2) proficiency in geological science topics that emphasize geologic processes and the identification of minerals and rocks; (courses taught by Drs. Chan, Bartley, and Davis), (3) the ability to visualize and solve geological problems in three and four dimensions (courses taught by Drs. Bartley and Dinter); (5) the ability to apply principles of geology, elements of geophysics (Dr. Thorne).

Below are shown the FTE contributions of the various faculty members that contribute most directly to the geological engineering program at the University of Utah.

Faculty support of the Geological Engineering program

<table>
<thead>
<tr>
<th>Core Faculty *</th>
<th>FTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>W. P. Johnson</td>
<td>1.00</td>
</tr>
<tr>
<td>D. K. Solomon</td>
<td>1.00</td>
</tr>
<tr>
<td>P. W. Jewell</td>
<td>1.00</td>
</tr>
<tr>
<td>J. R. Moore</td>
<td>1.00</td>
</tr>
<tr>
<td>L. E. Stright</td>
<td>1.00</td>
</tr>
<tr>
<td><strong>Departmental total</strong></td>
<td><strong>5.00</strong></td>
</tr>
</tbody>
</table>

In addition to our existing core faculty, we have additional faculty efforts (estimated time that is equivalent to another 1.0 FTE or more) that are contributed to the program from Departmental faculty teaching required geological engineering courses, administrative support, and allied engineering faculty in other departments who teach required courses in the program.
The very favorable student to faculty ratio (~ 4:1) allows significant personal contact with all students in the program. A number of geological engineering undergraduates have been involved in research projects which receives significant institutional financial support from the UROP (Undergraduate Research Opportunities Program).

Student advising duties were handled by Dr. Jewell from 2009-2014. During the current academic year (2014-2015), these duties have been handled by Dr. Moore. The university service activities, professional development and interactions with industrial and professional practitioners are outlined in the faculty CVs or Appendix B.

**D. Professional Development**

All faculty members are encouraged to pursue professional development by attending meetings and workshops. Information is distributed when it comes to the Department of Geology and Geophysics, but most faculty are aware of opportunities through their own subdiscipline professional societies. In a number of cases, the faculty has been encouraged to take advantage of special professional development programs, such as the NSF Cutting Edge Workshops. The Department has sponsored: 1) graduate students to attend the workshops for PhD students interested in academic careers; 2) new faculty to attend the Early Career workshop (time management, how to balance all the expectations, and meeting their discipline program director at NSF), and 3) established faculty to attend topical workshops (teaching hydrology, sedimentary geology, etc.). Some of these NSF workshops are free, but funds to get to the workshop have been provided by the Department if a faculty has no other sources.

Professional development occurs regularly within the geological engineering program as faculty attend professional meetings, ABET meetings and training sessions, Departmental and University Seminars, and University-sponsored development courses. Attendance at professional meetings is funded either by grants, State appropriated travel funds, or discretionary funds within the College of Mines and Earth Sciences.

The University of Utah maintains a Center for Teaching and Learning Excellence (http://ctle.utah.edu/). This organization provides numerous faculty services associated with professional development. These services include (1) peer consultation/observation, (2) faculty orientation, (3) resource library, and (4) numerous seminars and workshops. The center has been utilized by faculty in the geological engineering program and represents a significant resource for professional development.
E. Authority and Responsibility of Faculty

The Geological Engineering Committee has the authority to set and maintain the Geological Engineering Program curriculum, and their decisions are subject to review only by the Department chairperson or higher administrative authority. The Geological Engineering Committee coordinates with the Undergraduate Affairs Committee of the Department of Geology and Geophysics, but reports directly to the departmental chair. The Geological Engineering Committee decides what courses are necessary for students to receive a good solid basic science, engineering science and engineering design background, while the Undergraduate Affairs Committee ensures that other university requirements for graduation are met.

New courses in the College of Mines and Earth Sciences (be they for the geological engineering program or otherwise) are vetted by the Undergraduate Affairs Committee which makes recommendations to the departmental faculty as a whole. Following approval by the faculty, the course proposal is submitted to the College Curriculum Committee for final approval.

The Dean of the College of Mines and Earth Sciences and those higher in the administration play only a minor role in establishing educational objectives, student outcomes, or the curriculum needed to support these. For instance, the Dean has only an advisory role in approval of new courses in the College of Mines and Earth Sciences.
CRITERION 7. FACILITIES

**A. Offices, Classrooms and Laboratories**

The University of Utah Department of Geology and Geophysics just is housed in one of the first Earth Science LEED-certified green buildings in the country, with museum-like geologic art displays that visitors and alumni have hailed as spectacular, impressive, and beautiful. The Frederick Albert Sutton Building (FASB), dedicated April 17, 2009, is a distinctive and unique, 4-story (91,000 ft²) state-of-the-art facility of classrooms, labs, and office designed specifically for the Department of Geology and Geophysics.

The Sutton Building is the first new construction LEED-certified building on the academic campus of the University and is one of the first LEED-certified Earth Science buildings in the country. The Leadership in Energy and Environmental Design (LEED) rating system was developed by the U.S. Green Building Council to provide standards for environmentally sustainable construction. The Frederick Albert Sutton Building received the Association of General Contractors 2008 Building Project of the Year award (Category: Higher Education 0-$25 million in the state of Utah).

The Sutton building blurs traditional boundaries between bricks and mortar, and educational programs. A college class in sustainability was created where students got involved in learning about green aspects and actually proposed practicum projects that were then incorporated into the building construction. This class was spearheaded and implemented by one of our Geological Engineering faculty (Dr. William Johnson) and was interdisciplinary involving other departments (Biology and Civil Engineering), faculty, and students on campus. The geological engineering related “green” projects incorporated into the building added permanent enhancement to the building along with teaching and educational components. It shows responsible use of resources and how to utilize creative problem solving to conserve.

Distinctive features of the building include:

- Unique, inviting geologic designs of: cross bedding pattern in the concrete foundation; “a river runs through it” (a pebble tile “stream” inside the entrance); “confluence” lobby with spectacular Eocene Green River fossil fish and plant walls; educational geologic displays (with explanatory signs); and many natural stone elements.
- Reinforced concrete foundation for vibration-free analytical measurements.
- A showcase for energy efficient and sustainability projects such as:
  - solar tube lights (brings natural light in, reduces energy use)
  - xeriscape & rock monoliths (conserves water, shows natural elements)
  - rainwater collection (recycles water)
  - roof garden (automatic system, reduces reflectivity, helps retain heat)
  - pervious cement (3rd installation in the state of Utah)

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1Include information concerning facilities at all sites where program courses are delivered.
- energy monitoring (real time comparisons of energy use of our “green” vs. traditional buildings)
- retention pond (collects water instead of it being funneled to storm water drainage)

Previously the department was spread out in 5 different buildings. We have now been centralized into one new, state-of-the-art building that can service all the needs of our program in a much more efficient manner. The centralization creates more collegiality and strengthens communications amongst our faculty and students. Space was designed to be flexible and adaptable. We now have one of the best facilities to house a competitive geological engineering program in the country. This is a strong asset to support our educational objectives, and to train geological engineers on modern building and construction principles that conserve Earth resources. This building also impacts our outcomes in providing an attractive built environment that raises the visibility of our programs.

1. Offices (Administrative, Faculty, Clerical, Teaching Assistants)

The new Sutton Building provides us with spacious, functional offices. The Geology and Geophysics administrative office is centralized so there is convenient access to all of the clerical staff, with the adjoining copy and mailbox room close by.

Faculty have convenient offices with a nearby work space (either next door or across the hall). Graduate students and teaching assistants reside in group offices that can house up to about 10 desk spaces. Graduate students have the most spectacular space in the building with large windows and spectacular scenes of mountains and valley for east, south, and west views. Teaching assistants have access to a number of student gathering areas available on all the floors where offices and classrooms are present. These gathering areas have comfortable seating, table and chairs, as well as white boards. The gathering areas can be used to meet students, or to have informal group meetings.

2. Classrooms

We have new classrooms with some of the latest technology for computing and media services. Students have wireless internet access throughout the building. A lecture hall (seats 80) is available in addition to the traditional classrooms and teaching laboratories. Teaching laboratories are centralized with respect to function and built in with necessary storage and workspaces for appropriate support equipment or samples needed for teaching.
Table 7A.1 Geological engineering classrooms and laboratories

<table>
<thead>
<tr>
<th>Class #</th>
<th>Class Title</th>
<th>Room # and Bldg. where lecture or labs are conducted (square footage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEO 3010</td>
<td>Geophysics</td>
<td>250 FASB (951)</td>
</tr>
<tr>
<td>GEO 3060</td>
<td>Structural Geology</td>
<td>250 FASB (951)</td>
</tr>
<tr>
<td>GEO 3075</td>
<td>Introduction to Geological Engineering</td>
<td>485 FASB (320)</td>
</tr>
<tr>
<td>GEO 3080</td>
<td>Earth Materials I</td>
<td>375 FASB (644)</td>
</tr>
<tr>
<td>GEO 3090</td>
<td>Earth Material II</td>
<td>375 FASB (644)</td>
</tr>
<tr>
<td>GEO 3400</td>
<td>Comp. and Field Methods in Applied Geology</td>
<td>206 FASB (725)</td>
</tr>
<tr>
<td>GEO 5150</td>
<td>Geological Eng. Design</td>
<td>489 FASB &amp; 206 FASB (637)</td>
</tr>
<tr>
<td>GEO 5350</td>
<td>Groundwater</td>
<td>250 FASB (951) &amp; 206 FASB (725)</td>
</tr>
<tr>
<td>GEO 5360</td>
<td>Fluid Dynamics of Earth Materials</td>
<td>483 FASB (320) &amp; 206 FASB (725)</td>
</tr>
<tr>
<td>GEO 5385</td>
<td>Introduction to Groundwater Modeling</td>
<td>206 FASB (725)</td>
</tr>
<tr>
<td>GEO 5390</td>
<td>Solute Transport and Subsurface Remediation</td>
<td>206 FASB (725) &amp; 483 FASB (320)</td>
</tr>
<tr>
<td>GEO 5560</td>
<td>Numerical Methods in Geosciences</td>
<td>206 FASB (725)</td>
</tr>
<tr>
<td>GEO 5760</td>
<td>Stratigraphy and Sedimentary Processes</td>
<td>330 FASB (675)</td>
</tr>
</tbody>
</table>
3. Laboratories

Modern research laboratories have been centralized to avoid redundancy and to make more efficient use of space. Thus faculty that might have formerly had their own wet chemistry labs may now share a larger single wet chemistry lab (to centralize expensive fume hoods, etc.). All labs were designed to have exposed ceilings in facilitate additions of new equipment or support lines with minimal effort. Laboratories are distributed on the floors according to their function. First floor laboratories are those that need access to the loading dock and those involved with more sample or equipment storage. Second floor laboratories are largely related to computing and geophysics. Third floor laboratories are largely related to geology. Fourth floor laboratories are largely related to geochemistry and geological engineering.

Several laboratories are used to teach various components of the geological engineering program. FASB 493 contains various wave tanks, tubes, and other devices that are used to teach labs for GEO 5360 (“Fluid Dynamics of Earth Materials”). FASB 425 is used for dating and tracing groundwater flow as part of projects in GEO 5350 (“Groundwater”) and GEO 5390 (“Solute Transport and Subsurface Remediation”).

New analytical instrumentation space is available, and we own and operate a QEMSCAN instrument for rapid quantitative mineral evaluation scans. Although this instrument is widely used in the minerals industry, we were only the second university in the U.S. to acquire such an instrument. We anticipate there will be new techniques developed for the QEMSCAN that will
have important geological engineering applications (porosity, permeability, rock mechanics structures and more).

**B. Computing Resources**

There are no serious limitations regarding the use of software packages in the geological engineering program. The geological engineering program primarily utilizes the student computer lab located in 206 FASB. This lab consists of 18 Shuttle XPC Model SN85G4 computers running Microsoft XPSP3 as the operating system. Each computer is equipped with an AMD Athlon 64 processor, 2 GB DDR RAM, and a 17-inch VG910b monitor. Additionally, the geological engineering program utilizes 17 IMac computers as part of the GG Mobile Lab located in 375 FASB.

The following software packages are available on each computer in 206 FASB:

**A. Specialized Technical Software:** Aqtesolv, ArcGIS, Phreeqc Interactive, 3dem, Loadest, StereoWin, GM-SYS, Geo-Slope, Plate River Associates, Inc, IES/PetroMod, Kingdom Suite, Microdem, MatLab, GMS, Vista Sesimic Processing, Geochemist's Workbench

**B. General Software:** Microsoft Office, Eset/NOD32-next update, Mozilla Firefox, Adobe Illustrator, Internet Explorer, Google Earth, Adobe Reader, Ken Wards Zipper, WinaXe_Plus, Putty, WinSCP.

**C. Guidance**

Students in the geological engineering program are integrated into the tools, equipment, computing resources, and laboratories from the very time they begin their academic careers. The introductory geological engineering course and subsequent core geology courses all utilize existing technology, laboratory supplies, and equipment into exercises that, as described in the preceding pages build progressively on each other.

**D. Maintenance and Upgrading of Facilities**

The geological engineering program has a line-item (guaranteed) equipment replacement and maintenance budget that is currently $6000 per annum. Actual expenditures for equipment used in the Geological Engineering program are typically much greater than the line-item amount (see below.)

Of the $6000 line-item amount, $1000 comes from the Department of Geology and Geophysics as part of it annual base budget, and $5000 of this comes from the Dean’s office of the College of Mines and Earth Sciences These funds are used for maintaining teaching equipment (highest priority) and also for acquiring new equipment. The geological engineering program utilizes the departmental curator for the storage and security of equipment. The curator provides a detailed
list of equipment required for each class in geological engineering to establish a maintenance schedule for teaching equipment. Requests to repair and replace equipment can also come from individual faculty. In addition, faculty teaching classes that are required by geological engineering can request funds for new equipment by way of a written proposal to the departmental chair. These proposals are ranked based on the following criteria:

a. Potential of the proposed equipment for enhancing the mission of the geological engineering program
b. Uniqueness of the proposed equipment within the Geological Engineering Program (i.e. does the proposed equipment provide an entirely new capability or does it expand on existing capabilities.)
c. Reasonableness of the cost of the proposed equipment.

E. Library Services

The University of Utah has three libraries on its campus: S. J. Quinney Law Library, Spencer S. Eccles Health Sciences Library, and J. Willard Marriott Library. The Marriott Library is the library used most by engineering faculty and students.

The Marriott Library currently has more than 3.5 million books and over 11,000 serial subscriptions. Through the regional “Utah Academic Library Consortium” students, faculty, and staff have reciprocal borrowing privileges at other colleges and universities throughout the state of Utah. The library is five to ten minutes walking distance from the main engineering building. The library is open 111 hours per week as follows: M-Th 7am-1am, Friday 7am-9pm, Saturday 9am-9pm, and Sunday noon-1am.

Marriott Library provides access to numerous online resources. These resources include article and physical-property databases, digital full-text journals, and a growing collection of e-books to support campus and distance education. The library’s e-book collection, including many online handbooks, is currently being developed among several products: EbscoHost, EBL, ebrary, Knovel, CRC, and Safari. Engineering related books are found in all of these collections.

The library’s Interlibrary Loans Department will borrow almost anything the user might need to support their academic program. The library offers the “Utah Article Delivery Service”, which will quickly deliver requested articles to a researcher’s desktop. It also has a policy of quickly obtaining copies of almost any engineering standard needed by faculty or graduate students (ASTM, ANSI, ASME, ISO, etc.). Engineering standards are purchased as needed with either faculty or librarian approval.

The library’s Education Services Department exists to promote information and computer literacy among students, faculty, and staff. Numerous special short courses are taught each term to cover basic library skills, research strategies, use of the online catalog, widely used software programs, and other electronic resources. The Education Services Department has teamed with the university’s Writing Program to offer E-LEAP (Liberal Education Advanced Program)
specifically for engineers. This program provides in-depth study of engineering ethics and their application to situations involving engineering failures.

Librarians provide in-class instruction for library research and writing assignments, and have created many dozens of online guides to assist students with all aspects of library research and the use of information technology. Each department has a guide directing students to the best resources in that discipline. Examples of library support include the semi-annual Dissertation Bootcamp for students writing theses or dissertations, creation of the quiet Graduate Reading Room and presentation practice rooms, and numerous one-on-one consultations.

The library has provided space to create a Faculty Center for programs that serve faculty and students. The Writing Program, the Digital Scholarship Lab and the Statistics Consultation Service provide support for student projects. Faculty are supported by the Center for Teaching and Learning Excellence, the Teaching and Learning Technologies Center and the Grant Development Service. A Large-Data Repository is currently under development to archive and share faculty research data.

Through its Faculty Center the library provides teaching faculty with technical assistance in creating online course content. Due to the cost of equipment and software this is not a free service but grant money encouraging the development of online courses, and online reserve materials for regular courses, is available. The Faculty Center works with faculty to create the exact course content requested, including content from new audio and video studios. It helps instructors with all course-related uses of Canvas (the online-course software of the university).

The “Knowledge Commons” in the Marriott Library offers audiovisual and computing resource and assistance. More than 500 networked computers give electronic access to information held worldwide. Additionally, hundreds of software packages are available to students including AutoCAD, LabVIEW, Maple, Mathematica, SAS and others.

The Knowledge Commons offers many specialty software packages of interest to engineering students and faculty. The library also operates three campus computing labs located in residence halls. The Marriott Library and all computing labs work closely with faculty to purchase media-materials and software to support course curricula (ChemCAD, Maple, CADvance, Programming Language software, etc).

Engineering related video and CD-ROM resources are requested in the Knowledge Commons where equipment for these formats is available. Microfiche are also requested at the Knowledge Commons for the same reason. Some databases, such as Ceramics Phase Diagrams, are loaded on student computers for use with class assignments. The library has completed a digital authoring studio to aid student groups and faculty in their digital authoring endeavors. This studio has high-end audio and video authoring tools.

The Knowledge Commons is operated by 9 librarians, as well as numerous technical support personnel. All librarians provide reference help for patrons at the desk, quick assistance over the phone, online assistance via Chat Reference, or in-depth consultations by appointment. The librarians are available for course-integrated instruction sessions, and specialty classes tailored to
the college’s specific needs. A patent specialist is available in the library for instruction and one-on-one assistance.

Each academic department is assigned a librarian as a liaison, instructor and general problem solver. Five librarians directly serve the departments of the College of Engineering, while another 2-3 librarians are also involved in instruction and collection development.

**F. Overall Comments on Facilities**

In both ABET reviews and general accreditation reviews of the University of Utah, the facilities for the geological engineering degree as well as its host department and college receive laudatory comments for being state-of-the-art as well being available to students even in the earliest part of their careers.
CRITERION 8.  INSTITUTIONAL SUPPORT

A. Leadership
The University of Utah operates under a two-provost system, led by President David Pershing. Dr. Vivian Lee is the Vice President (and provost) for Health Sciences and Dr. Ruth Watkins is the Vice President (and provost) for Academic Affairs. The Department of Geology and Geophysics formally resides within the College of Mines and Earth Sciences under Dean Francis Brown. The Chair (Dr. John Bartley) reports directly to the Dean.

Like the other departments at the University of Utah, ours is an assemblage of teacher-scholars organized into a self-governing unit that shares responsibility for its duties. The faculty sets the academic standards, admits the students, plans, delivers and assesses the curriculum, sets degree requirements, and grants degrees. In addition to teaching, all professors are expected to engage in research, service and to help promote the department through scholarship and by working with various media outlets. The specific responsibilities of each faculty member are determined by the Department Chair in consultation the faculty member as a function of the changing needs of the unit.

The department chair has responsibility for oversight of all aspects of the department management including HR issues, academic affairs, space allocations, communications, fund raising, teaching equity, and research related issues including conflicts of interest, cost sharing, hiring of faculty, start-up packages, research space, interdisciplinary program development, as well as, supporting the professional development of faculty, staff and students.

Once a month during the academic year the department holds a faculty meeting. Major components of these monthly meetings are reports from the undergraduate and graduate chairs including items from the committee meetings that need to be discussed with the full faculty. In addition to the monthly faculty meeting, once a year the faculty holds a retreat to review and evaluate progress toward strategic objectives, as well as to plan the next year’s tactics.

Occasionally, smaller group meetings are held as needed to work through issues confronting the department such as hiring new faculty or as related to committee level business. All decisions of substance are put on record in the form of meeting minutes, which are reviewed, voted upon, and archived. Less important matters or informational items are communicated by e-mail. In addition to formal meetings, extensive informal interactions take place through office visits and discussions at social, professional and informal gatherings.

B. Program Budget and Financial Support
The geological engineering program is one of 3 academic programs within the Department of Geology and Geophysics (the other two being the Geology and Earth Science Teaching Composite majors). At the University of Utah, budgeting and financial management are done within academic units (e.g., Department of Geology and Geophysics). Some of the Department’s resources are shared between degree programs, (e.g. administrative staff, curator,
lecture halls), while others are devoted specifically to geological engineering (e.g. teaching laboratories, equipment, faculty members.)

The geological engineering program budget is largely set by consultation with the geological engineering faculty and the Department Chair. The budget is based on the limited state resources available. If needs exceed the available, the interested parties examine potential initiatives to obtain additional resources from the Dean, other College “seed” sources, or from industry.

Institutional support for the program is mainly driven by the faculty (what they push for) and the desire to serve the needs of the students.

Hard monies to support the geological engineering program come from the Utah state line item budget. The total Department budget (mostly faculty salaries, staff, and teaching assistants) is on the order of $1.8 million. Throughout the “Great Recession”, we have taken significant budget cuts like many institutions nationwide. We have tried to be selective in the cuts to maintain our core. So far we have been able to manage the majority of the cuts through phased retirements.

Institutional support comes from the “hard” faculty lines. Four faculty members are devoted full time to the geological engineering program. In addition, various other faculty members contribute a fraction of their time in support of the program. This includes faculty members from the departments of Mining Engineering, Metallurgical Engineering, and Civil and Environmental Engineering. The vast majority of courses required by the geological engineering program that are taught within the departments of Geology and Geophysics, Mining Engineering, Metallurgical Engineering, and Civil and Environmental Engineering are taught by full-time regular faculty members.

Soft monies for the program can come from the research dollars generated by the faculty through extramural funding and grants. For the entire Department, this ranges on the average order of about $2 million per year. These funds are commonly used to conduct the research and to also support graduate students (stipends) although undergraduates, including geological engineering students are often supported as lab assistants or graders for courses.

Teaching assistantships are an integral source of support for graduate students and are largely used in high enrollment courses such as those in the core geology courses. Teaching assistants are supported by a variety of institutional sources:

1. Teaching support by the institution in terms of graders, teaching assistants, teaching workshops, and so forth.
2. Acquisition, maintenance, and upgrade of infrastructures, facilities, and equipment used in the program.
3. Adequacy of the resources with respect to the students in the program being able to attain the student outcomes.

C. Staffing

The geological engineering program utilizes staff in the Department of Geology and Geophysics and within the College of Mines and Earth Sciences. Departmental staff includes Ms. Judy
Martinez (student records and academic advising), Ms. Thea Hatfield (payroll), Mr. Robert Doerr (accounting), and Mr. Dustin Porlas (departmental records and assistant to the chair. The curator position is currently filled by Quintin Saharian. The fraction of the staff resources devoted to the GE program is estimated to be approximately 20% of the total. Institutional services to support the program also include (1) two full time computer support staff within the College of Mines and Earth Sciences, (2) instructional media services for maintaining video and projection equipment, and (3) extensive staff and capabilities at the Marriott Library. Currently we have adequate support for personnel and institutional service to meet the program needs. However, more serious budget cuts could threaten the stability of all our programs, not just geological engineering.

Staff retention over the years has remained quite good as evidenced by the longevity of Ms. Martinez (7 years) and Ms. Hatfield (9 years) service within the department. Compensation issues have involved loss of two recent staff persons (accounting and assistant to the chair) in recent years.

D. Faculty Hiring and Retention

The process of hiring and retaining qualified faculty at the University of Utah is administered centrally, and information is provided at the following web address: http://diversity.utah.edu/faculty/online. An excerpt from that document (with parts related to the School of Medicine excised) is given below:

Faculty Hiring

The faculty hiring process at the University of Utah is supervised by different offices to ensure compliance with federal and state regulations and recruit diverse pools of candidates. For academic departments and programs that are not part of the health sciences, the Office for Equity and Diversity provides oversight for faculty job posting and advertising, recruitment and position offers. The Office for Equal Opportunity and Affirmative Action ensures that federal and state reporting requirements are met. The Office for Faculty provides oversight for the faculty appointment, hire, and tenure processes.

The Office for Equity and Diversity strives to meet three goals in faculty recruitment:

• Provide information to help departments recruit diverse pools of candidates;
• Ensure that federal and state regulations are followed in recruitment and job offers;
• Provide information and resources to assist departments in attracting and securing outstanding candidates.”

An overview of the process is given at: http://diversity.utah.edu/uploads/faculty/pdf/Faculty_Hiring_Proposal_Quick_Guide.pdf and this site also includes Step-by-step instructions.
Since 2011 an online faculty recruitment and application system (PeopleAdmin) has been used to process all faculty, staff and student job postings and applications. PeopleAdmin is accessed through the University’s Campus Information System. Thus far the system appears to work quite well, and makes access easy for administrators who have reason to examine files related to a particular hire.

Many documents related to faculty hiring are also accessible in pdf format for assistance in following the rather complicated flow of materials (made easier through PeopleAdmin). These are located at http://diversity.utah.edu/faculty/online.

A full PeopleAdmin Training Packet is available at: http://www.hr.utah.edu/openposition/PeopleAdminTraining.

Strategies used to retain current qualified faculty:

When it appears that a faculty member may leave her or his position at the University, and the department wishes to retain that faculty member, a variety of strategies are employed to try to convince the faculty member to remain at Utah. These normally begin with the department Chair, and also normally involve the college Dean, and ultimately the Sr. Vice President for Academic Affairs. Amongst these strategies are:

1) Having a conversation with the faculty member to determine what changes in her or his status, compensation, duties, etc., may convince her or him to remain at the U.

2) Constructing a retention package and presenting it to the faculty member for consideration, but only after clearing the package with the Senior Vice President for Academic Affairs. The package may involve some combination of: change in rank, change in compensation, change in teaching assignments, support for research by the faculty member for a limited time, additional research space, and so on. Particulars will depend on the offer made from another institution (normally at higher salary, but not necessarily at higher compensation when benefits are included).

3) Reminding the faculty member that Salt Lake City is a very pleasant place to live, and that the school attempting to purloin them is situated in a much less desirable part of the country. Sometimes that is enough, particularly if the faculty members have children in school with their own myriad social connections.

It is sometimes not possible to satisfy a faculty member even though all requests may be granted. In general this is because factors beyond the control of the University are at play. For example, the college lost one very promising young faculty member to another University even though all requests for remaining at Utah were met—what we could not do was to move two sets of aging parents nearer the candidate and his wife.

In some other cases, it is not possible to match offers from other institutions, and in this way the college has lost one faculty member to the King Abdula University of Science and Technology, where financial resources for attracting faculty are seemingly bottomless.
E. Support of Faculty Professional Development

All faculty members are encouraged to pursue professional development by attending meetings and workshops. Information is distributed when it comes to the Department, but most faculty are aware of opportunities through their own subdiscipline professional societies. In a number of cases, the faculty have been encouraged to take advantage of special professional development programs, such as the National Science Foundation Cutting Edge Workshops. The Department has sponsored: 1) graduate students to attend the workshops for PhD students interested in academic careers; 2) new faculty to attend the Early Career workshop (time management, how to balance all the expectations, and meeting their discipline program director at NSF), and 3) established faculty to attend topical workshops (teaching hydrology, sedimentary geology, etc.). Some of these NSF workshops are free, but funds to get to the workshop have been provided by the Department if a faculty has no other sources.

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1. **Curriculum**

*The program must demonstrate that graduates have:*

(1) **the ability to apply mathematics including differential equations, calculus-based physics, and chemistry, to geological engineering problems;**

At the University of Utah, this is accomplished through completion of 2 years of math and 1 year each of college chemistry and physics and application of this knowledge in subsequent courses as described in Program Outcome (a).

(2) **proficiency in geological science topics that emphasize geologic processes and the identification of minerals and rocks;**

This is accomplished through completion of courses GEO 3075, 3070, and 3090 (7 semester hours).

(3) **the ability to visualize and solve geological problems in three and four dimensions;**

This is accomplished through completion of courses that emphasize mapping and interpretation of geologic structures (GEO 3060, GEO 4500, and GEO 4550; 10 semester hours).

(4) **proficiency in the engineering sciences including statics, properties/strength of materials, and geomechanics;**

This is accomplished through completion of basic engineering courses in statics (CVEEN 2110), strength of materials (MG EN 5150), rock mechanics (MG EN 5160) and geotechnical engineering (CVEEN 3310 and 5305), plus portions of the field course (GEO 4550) and design courses (GEO 5150, 5390) (22 semester hours)

(5) **the ability to apply principles of geology, elements of geophysics, geological and engineering field methods; and**
This is accomplished through completion applied geology and geological engineering courses GEO 3010, 4500, 4550, 5760.

(6) engineering knowledge to design solutions to geological engineering problems, which will include one or more of the following considerations: the distribution of physical and chemical properties of earth materials, including surface water, ground water (hydrogeology), and fluid hydrocarbons; the effects of surface and near-surface natural processes; the impacts of construction projects; the impacts of exploration, development, and extraction of natural resources, and consequent remediation; disposal of wastes; and other activities of society on these materials and processes, as appropriate to the program objectives.

Accomplished through completion of courses in surface fluids and groundwater (GEO 5350 and GEO 5360), groundwater contamination and remediation (GEO 5390), exploration and natural resource development (portions of GEO 5350 and GEO 5760).

2. Faculty
Evidence must be provided that the program’s faculty members understand professional engineering practice and maintain currency in their respective professional areas. The program’s faculty must have responsibility and authority to define, revise, implement, and achieve program objectives.

This requirement is met by the program as discussed under Criterion 6 above.
Appendix A – Course Syllabi

GEO 3010: Geophysics

_Instructor:_ Michael Thorne, Associate Professor (FASB 267), Tel.: +1-801-585-9792, E-mail: michael.thorne@utah.edu

_Credit hours:_ 3 semester credits

_Textbook:_ H. R. Burger, A. F. Sheehan, and C. Jones, "Introduction to Applied Geophysics"

_Course information:_

_Catalogue description:_ Fulfills Quantitative Intensive BS. Applications of physical principles to solid-earth dynamics and solid-earth structure, at both the scale of global tectonics and the smaller scale of subsurface exploration. Acquisition, modeling, and interpretation of seismic, gravity, magnetic, and electrical data in the context of exploration, geological engineering, and environmental problems. Two lectures, one lab weekly.


_Required_ for Geological Engineering Curriculum

_Course goals:_

_Outcomes of instruction:_ This course covers fundamentals in the lectures, global geophysics in 3 of the 13 labs, and applied geophysics in 10 of the 13 labs. Geological engineering design is pervasive, in the form of experimental design to achieve geological engineering objectives. Many labs involve student data collection using geophysical equipment (seismic refraction, magnetometer, gravimeter, GPS, altimetry) to address geological engineering problems (depth to basement, also detection of buried pipe, subsurface structure). Geological engineering problems are also addressed using data provided (seismic hazards, subsurface structure). Two labs involve analysis and interpretation of data (gravity and magnetic) via forward modeling and another two labs involve forward modeling of both seismic reflection and refraction data. The culmination of the lab is a field trip to collect geophysical data (in this semester we collected extensive gravity data to determine the possible location of a buried fault in conjunction with Earthquake hazard analysis).
final objective of this exercise is to produce a “consulting style” report. The students must work in teams to produce the report in a manner similar to working for a consulting company.

**Contribution of course to meeting the professional component:** This course contributes 2 credits of basic science and 1 credit of engineering science to the geological engineering curriculum.

**Student outcome addressed by this course:** k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

**Topics covered:** Global Earth structure (both compositional and mechanical); Fundamentals of seismic waves (theory of elasticity); Seismic refraction technique; Seismic reflection technique; Global seismology; 3D tomographic imaging of Earth structure and basic inverse theory; Earthquake processes; Electrical resistivity technique; Fundamentals of gravity; Figure of the Earth (geoid, potential surfaces, ellipsoids and map datums); Gravitational anomalies from buried objects; Principle of isostasy; Earth Geomagnetic Field (generation of and overall properties); Paleomagnetic poles; Fundamentals of rock magnetization; Measuring magnetic properties of the subsurface; Plate Tectonics (plate reconstruction based on paleomagnetics, plate motions on a sphere); Radioactivity (theory and field based techniques).

**Prepared by:** M. Thorne, 5/1/15
GEO 3060: Structural Geology and Tectonics

Instructor: John Bartley

Required by Geological Engineering program

Credit hours: 3 semester credits

Textbook: Twiss and Moores, Structural Geology (2nd Ed.), Freeman; Marshak and Mitra, Basic Methods of Structural Geology, Prentice-Hall.

Course information:

Catalog description: Fundamentals of rock deformation and applications to petroleum geology, mining, and geological engineering; mechanics of rock flow, fracture and folding; geometric techniques of structural analysis; introduction to tectonics. Field trips required. Two lectures, one lab weekly.

Prerequisite(s): Recommended Prerequisite: GEO 1110 OR Equivalent AND MATH 1060 OR Equivalent). Fulfills Quantitative Intensive BS.

Required for the Geological Engineering Curriculum

Course goals:

Outcomes of instruction. The objectives of this course are to achieve competence in identifying the types & occurrence of earth structures, the methods of their analysis, and applications of the analyses to engineering problems such as geologic hazards (rupture segmentation, rock slides), mining (slope stability, tunneling), petroleum geology (Exploration, Reservoir Eng.) and hydrology & environment.

Contribution to professional component: This course contributes 3 credits of math and basic science to the geological engineering curriculum.

Student outcome addressed by this course: a) an ability to apply knowledge of mathematics, science, and engineering

Topics covered

A. Basic descriptive structural geology (2 lectures, 4 labs)
   1. Geometry of geologic structures
   2. Types of geologic contacts
   3. Geologic map interpretation
B. Brittle deformation
1. Fractures
   a. Joints [1 lecture]
   b. Faults [4 lectures]
2. Stress and fault mechanics
   a. Geometry and mathematical description of force and stress [1 lecture]
   b. Coulomb-Navier failure criterion [1 lecture]
   c. Anderson fault theory; effect of pre-existing fractures [1 lecture, 1 lab]
   d. Effect of pore pressure; hydrofracture [1 lecture]
   e. Observed characteristics of faults in the field in light of theory [1 lecture]

C. Ductile deformation
1. Geometry and kinematics of ductile deformation
   a. Evidence of ductile flow in rocks [1 lecture]
   b. Description of folds [2 lectures, 2 labs]
   c. Description of rock fabrics and shear zones [2 lectures]
   d. Kinematic significance of folds and rock fabrics [1 lecture, 1 lab]
2. Finite strain [2 lectures, 1 lab]
3. Rock rheology and microstructural processes [2 lectures]

D. Tectonics
1. State of stress in the crust and lithosphere [1 lecture]
2. Structural geology and plate tectonics [1 lecture]
3. Large-scale anatomy of plate boundaries [1 lecture]

Prepared by: J. M. Bartley, April 6, 2015
GEO 3070: Mineralogy and Petrology for Engineers

**Instructor:** Michael Davis, Email: michael.g.davis@utah.edu. Phone: 801-587-8846. Office: FASB 227. Office hours: Monday through Thursday from 11:00 – 12:00; or by appointment.

**Credit hours:** 2 semester hours. Course runs in the second half of the semester.


**Course information:**

**Catalog description:** Introduction to physical and chemical properties and the origins of common rocks and minerals. Practical skills for identification, classification, and description in the field. Overview of characteristic geologic settings and association in which economically significant rocks and minerals are found. Two lectures, two labs weekly.

**Prerequisites:** None.

**Required** for the Geological Engineering Curriculum

**Course goals:**

**Outcomes of instruction:** Students are assumed to already have been introduced to minerals and rocks in an introductory geology class. The purpose here is to go into somewhat greater depth, emphasizing:

1. Physical and chemical properties of rocks and minerals
2. Practical skills for identification of rocks and minerals in the field
3. Familiarity with some common minerals and rocks
4. Introduction to characteristic geologic settings and associations of minerals and rocks

**Contribution to meeting the professional component:** This course contributes 2 credits of engineering science to the Geological Engineering curriculum.

**Topics covered:** Physical properties of minerals; crystal symmetry; mineral identification of sulfides, oxides, metals, carbonates, phosphates-sulfates, halides, silicates (neso-, soro-, cyclo-, chain-, sheet-, tecto-); distinguishing properties of rock types including composition and texture; rock identification of igneous (extrusive and intrusive), sedimentary (siliciclastic, chemical and biological), and metamorphic rocks focusing on composition (mineralogy) and texture (grain sizes and structures); introduction to phase diagrams; geologic/tectonic settings of rocks and minerals.

**Prepared by:** Michael Davis, 3/26/2015
GEO 3075: Introduction to Geological Engineering

Instructor: Jeffrey Moore, Office: FASB 449, Tel.: 801-585-0491, E-mail: jeff.moore@utah.edu

Credit hours: 2. Course runs in the first half of the Fall semester.

Textbooks: No required textbook. Lectures and handouts will be made available electronically by the instructor before each class. Students are expected to bring copies to class.

Course information:

Catalog description: This course presents an introduction to the basics of: geological site investigation and project planning, engineering description of Earth materials, discontinuities in rock masses, stress and strains, stresses in the ground, groundwater effects, geologic hazards, rock excavation and support, and design on a geological engineering problem.

Recommended Prerequisites: MATH 1210, CHEM 1210.

Required for the Geological Engineering program.

Course goals:

Outcomes of instruction: Students will be introduced to and learn several key concepts in geological engineering, culminating in a term project design assignment. The course has been designed to fulfill the needs of civil and mining engineering, in addition to geology students.

By the end of the course students will:
- understand the breadth of geological engineering;
- be familiar with the practice areas covered by geological engineers;
- be able to apply knowledge of mathematics, science and engineering;
- be able to communicate effectively in an engineering environment;
- be able to design a system, component, or process to meet desired needs;
- recognize the need for, and an ability to engage in life-long learning.
- gain a knowledge of contemporary issues.

Contribution of the course to meeting the professional component. This course contributes 2 credits of engineering topics to the geological engineering curriculum.
**Student outcomes addressed by this course:** a) an ability to apply knowledge of mathematics, science, and engineering. c) an ability to design a system, component, or process to meet desired needs. h) the broad education necessary to understand the impact of engineering solutions in a global and societal context. i) a recognition of the need for, and an ability to engage in life-long learning. j) a knowledge of contemporary issues

**Topics covered:** Introduction to geological engineering; Site Investigation; Engineering description of materials; Geological hazards; Groundwater; Stresses in the Earth; Rock excavation and support.

The term project will involve team engineering design work on a geological engineering problem that will employ geo-engineering concepts introduced during this course.

**Prepared by:** Jeffrey Moore, Assistant Professor, University of Utah, Geology & Geophysics.
GEO 3090  Earth Materials II

Instructor: John M. Bowman

Credit hours: 3 semester credits

Textbook: Petrology, Blatt and Tracy, 3rd edition

Course information:


Prerequisite: GEO 1110, GEO 3080, and MATH 1210

Required for Geological Engineering program

Course information:

Outcomes of instruction: Basic competence in identification of igneous, sedimentary, and metamorphic rocks. Develop ability to deduce petrogenesis of an igneous, sedimentary, or metamorphic rock from correct identification and interpretation of its mineralogy and texture. Development of problem-solving and critical-thinking skills through series of quantitative homework and interactive laboratory exercises.

Contribution of course to meeting the professional component: This course contributes 3 credits of math and basic science to the geological engineering curriculum.


Prepared by: John R. Bowman, 6/5/09; updated by P. Jewell, 5/2015
GEO 3400 Computation and Field Methods in Applied Geology

**Instructor:** Paul W. Jewell  
**Credits hours:** 2 credits, 2 labs per week for 7 weeks, 2 hours per lab  
**Textbook:** MatLab for Engineers, Holly Moore (Prentice Hall Engineering Source)

**Course information:**

**Catalog description:** Computer and field methods for solving applied geoscience problems. Develops the computer and field skills required to solve problems in landscape evolution, geologic hazards, land use and natural resources. Meets computer programming requirement for geology, geological engineering, and environmental Earth Science majors.

**Prerequisites:** An introductory geology course

**Required** for the Geological Engineering program.

**Course goals:**

**Outcomes of instruction:** Proficiency in applying engineering and scientific software to solve problems in earth science, applied and engineering geology. Student will be able to state problems, write pseudo-code to solve the problems, and then translate pseudo-code into MatLab scripts or programs.

**Contribution of the course to meeting the professional component:** This course contributes 2 credits of math and basic science to the geological engineering curriculum.

**Student outcomes addressed by this course:** i) a recognition of the need for, and an ability to engage in life-long learning, k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

**Topics Covered:** Basic programming for solution of science and engineering problems. Data I/O, logical programming statements, arrays and matrices, plotting and graphing, operators and expressions, functions. Applications in slope stability, image processing, mapping, mineral exploration, basic engineering design, probabilistic hazards analysis.

**Prepared by:** Paul Jewell, 5/2015
GEO 4500 Field Geology

Instructor: Dr. David Dinter

Credit hours: 3 credit hours


Course information:

Catalog description: Practical field skills applicable to geological, geoengineering, and environmental studies developed through weekly field exercises in the Wasatch Front area. Results presented orally in class and/or in written reports targeted to a variety of potential users, including professional colleagues, government agencies, and the general public

Prerequisites: GEO 1110, GEO 3060, GEO 3080, GEO 3090, AND GEO 5760.

Required for the Geological Engineering Curriculum

Course goals:

Outcomes of instruction: Students learn and practice the techniques of geologic field mapping: describing rocks and landforms, measuring attitudes of planar and linear rock textures and structures, plotting contacts, faults and folds, preparing maps and cross sections, and communicating your results in professional-standard technical reports and oral presentations. The mapping, analytical, and visualization skills students learn provide them with a solid grounding for any Earth Science profession that involves the collection, organization, and analysis of 3-dimensional data (i.e., nearly every Earth Science profession), and will also be essential in Summer Field Geology and any geoscience graduate program. The communication (writing and speaking) skills student practice and master in this course will serve them well in any profession.

Contribution of course to meeting the professional component: This course contributes 3 credits of math and basic science to the geological engineering curriculum.

Student outcome addressed by this course: d) an ability to function on multi-disciplinary teams. g) an ability to communicate effectively.

Topics covered: Structural and stratigraphic field exercises augmented with projects addressing slope stability, fault scarp formation and degradation, groundwater analysis, or geophysical profiling. Use of topographic maps and the Brunton compass.

Prepared by P. Jewell, 6/2015
GEO 4550 Field Geology for Geological Engineering Majors

**Instructor:** David Dinter, Paul Jewell, Jeff Moore

**Credit hours:** 4 credit hours

**Textbook:** Fillmore, R., 2011, Geological Evolution of the Colorado Plateau of Eastern Utah and Western Colorado, University of Utah Press

**Course information:**

**Catalog description:** Meets with GEO 4510. Field mapping of faults, scarps, mass wasting units, Quaternary deposits, fractures, folds, and bedrock. Preparation of geologic and contour maps, cross sections, stratigraphic, stereonet, and rose diagrams, and a professional technical report. Discontinuities; rock mass classification; rock mass classifications in empirical design; estimation of rock mass parameters; empirical design of a tunnel and an engineered slope in rock. Hydrologic characterization and engineering designing of a bottom-land wetland.

**Prerequisites:** GEO 3075, GEO 5350, and CVEEN 3310

**Required** for the Geological Engineering Curriculum

**Course goals:**

**Outcomes of instruction** (first two weeks). GEO 4510 is intended to provide students with field skills and technical report writing experience that will serve as a sound basis for either a professional career or graduate school. Students define a problem to be solved, design a strategy to solve it, collect stratigraphic, structural, and engineering data, and generate original maps, cross sections, and quantitative diagrams that tell the geologic character and history of a region recorded in its rocks, sediments, and landforms. Results will be presented in professional quality technical reports. To put it all together successfully, you will draw upon many of the geologic and engineering skills you’ve learned in the classroom, laboratory, and field exercises.

(Second two weeks). Detailed mapping of surficial geologic features and integrating them into designs of public infrastructure is an important role that must be filled by practicing geological engineers and engineering geologists. Students conduct a geological hazards survey of two canyons along the Wasatch Front. Students also collect, compile and report all necessary rock mass strength information relevant for the proposed tunnel and its two portals. Rock mass strength evaluations are given to the tunnel design team, so students must deliver a well-organized and clear product that concisely describes all key rock mass parameters for tunnel and portal construction, and life-cycle design.

**Contribution of course to meeting the professional component:** This course contributes 2 credits of math and basic science and 2 credits of engineering topics to the geological engineering curriculum.
**Student outcome addressed by this course:** b) an ability to design and conduct experiments, as well as to analyze and interpret data.  d) an ability to function on multi-disciplinary teams.  g) an ability to communicate effectively.  k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

**Topics covered. (first two weeks)** Geologic map redrafted from your field map, with all necessary rock units, contacts, bedding attitudes, structural data, proper symbols, lat/long marks, and a complete legend showing all rock units, symbols, and the map scale, standard location maps showing position of your map area within the region and within Utah, stratigraphic column(s) showing thickness, lithologies, and descriptions of all map units, cross section consistent with geologic map and showing correct unit thicknesses and reasonable structural interpretations, and a complete geologic report in standard professional format, including: Illustrations, line drawings, photographs, maps showing key geologic relationships, and stereonets rose diagrams, and other graphs or tables as necessary to illustrate structural and paleocurrent measurement.

(Second two weeks). Engineering geology mapping techniques. Application of GIS techniques to Quaternary geologic mapping. Rock mass characterization and analysis.

*Prepared by P. Jewell, 6/2015*
GEO 5150 - Geological Engineering Design

Instructor: Daniel Seely, P.E., Adjunct Assistant Professor, phone: (801) 243-1195; email: dans@igesinc.com

Credit hours: 4 semester credits

Textbooks: There is no particular text book required for this course. Reference material for the design problem will be made available by the instructors as needed. Any comprehensive geotechnical engineering text book that the student has access to will be helpful in revisiting the basic concepts involved in various design applications. Some book references include:

- Landslides in Practice: Investigation, Analysis and Remedial/Preventative Options in Soils, Derek H.Cornforth
- An Introduction to Geotechnical Engineering, Holtz and Kovacs

Course information:

Catalog description. Comprehensive design experience in the field of geo-engineering, starting from the design of a site investigation and its cost estimate, and continuing with the analysis of site investigation data, and their use in students term project. Reliability-based design levels I, II and III, AASHTO LRFD as an example of design code. Slope stabilization methods, foundations on unstable slopes. Students prepare geotechnical and design reports, along with drawings in a design studio setting. Design process including the Environmental Impact Statement/Assessment, project formats. 2 2-hour lectures/labs with term project reviews or class design projects.

Prerequisites: MG EN 1050, MG EN 2400, MG EN 5150, CVEEN 2010, CVEEN 3310, GEO 3075, GEO 3400, GEO 4500, GEO 5350, GEO 5360

Required for the Geological Engineering program.

Course goals:

Outcomes of instruction: The objective of this course is to provide students with an extensive design experience in the field of geological engineering. Students will employ state-of-the-art limit-equilibrium and finite difference based geoengineering software available in the computer lab of the Department of Geology & Geophysics, and practical design methods to solve various design applications in geological engineering, including, embankment design, stability and deformability on soft ground.

Contribution of the course to meeting the professional component: This course contributes 4 credits of engineering topics to the geological engineering curriculum.

Student outcome addressed by this course: a) an ability to apply knowledge of mathematics, science, and engineering. c) an ability to design a system, component, or process to meet desired needs. d) an ability to function on multi-disciplinary teams. e) an
ability to identify, formulate, and solve engineering problems. f) an understanding of professional and ethical responsibility. g) an ability to communicate effectively. h) the broad education necessary to understand the impact of engineering solutions in a global and societal context. i) a recognition of the need for, and an ability to engage in life-long learning, j) a knowledge of contemporary issues.

**Topics covered:** Problem specification; drawing in a CAD environment; modeling; boundary conditions; computations; computer-aided contouring and graphing results; principles of limit equilibrium analysis and concept of safety factor; introduction to the finite difference method for stress and deformation analysis, review of design issues associated with slope stability, consolidation, ground settlement, and ground improvement techniques.

*Prepared* by D. Seely, 5/2015
GEO 5350 Groundwater

Instructor: D. Kip Solomon

Credits and Contact hours: 3 credits


Course information:

Catalog Description: Fundamental physics and mathematical models of groundwater flow with selected applications in the earth sciences and engineering. Specific topics include Darcy's Law, fluid storage, equations of flow, aquifer evaluation methods, and the role of ground water in geotechnical and geologic problems.

Prerequisites: MATH 1210, recommended prerequisite GEO 1110

Required for the Geological Engineering program.

Course goals:

Outcomes of instruction: This course covers the fundamental physics of flow through porous with selected applications in the earth sciences and engineering. Students apply their knowledge of mathematics, science, and engineering in order to understand and solve problems related to groundwater flow. Course materials emphasize the physical aspects of groundwater flow and its application to the evaluation of aquifer and groundwater characteristics. Contemporary issues regarding groundwater flow are discussed in lectures. Students are also introduced to groundwater modeling. The physical significance and numerical solutions to partial differential equations (i.e. the groundwater flow equation) are covered in this course.

Contribution of the course to meeting the professional component: This course contributes 2 credits of math and basic science and 1 credit of engineering topics to the geological engineering curriculum.

Student outcome addressed by this course: a) an ability to apply knowledge of mathematics, science, and engineering, c) an ability to design a system, component, or process to meet desired needs.


Prepared by D. K. Solomon, 3/2015
GEO 5360: Fluid Dynamics of Earth Materials

Instructor: Paul Jewell, FASB 445, phone: 1-6636; e-mail: paul.jewell@utah.edu

Credits hours: 3 semester credits

Textbook: Munson, Young, and Okiishi’s, Fundamentals of Fluid Mechanics. Additional readings devoted to application of fluid dynamics to earth science topics will be assigned during the course of the semester.

Course information:

Catalog description Derivation of the Navier-Stokes equations of fluid motion and momentum transport. Application to fundamental problems of Earth science and engineering design. Two lectures, one lab weekly

Prerequisite: MATH 2250 and CVEEN 2110 or permission of instructor

Required for the Geological Engineering Program

Course goals:

Outcomes of instruction: Just as engineers must have a thorough knowledge of fluid mechanics to solve many of the everyday problems they encounter, what earth scientist cannot have a complete understanding of his or her field without at least a basic knowledge of the motion of fluids? GG 5360 is intended to give both engineering and science students a solid background in fluid dynamics while at the same time imparting an appreciation for how applied math is used to solve practical problems in both science and the design aspects of engineering. A fundamental aspect of applied math will be exposure to and application of partial differential equations to problems of fluid flow.

Contribution of the course to meeting the professional component: This course contributes 1 credit of math and basic science and 2 credits of engineering topics to the geological engineering curriculum.

Student outcome addressed by this course: a) an ability to apply knowledge of mathematics, science, and engineering, b) an ability to design and conduct experiments, as well as to analyze and interpret data.

Topics covered: Continuum relationships; ODEs and their applications, boundary conditions, statics; balance of forces; Bernoulli’s equation fluid kinematics; material derivatives, divergence, vorticity, potential flow, convective acceleration; flownets, flow mapping, conservation of mass, Newton’s Law of Viscosity, stress, strain, Navier Stokes equations, Couette, Poiseulle flow; porous, fractured media, scaling analysis, dimensionless numbers,
lava, debris flows, and geological applications, turbulence, boundary layers, friction factors, Stokes Law, shallow water equations, gravity waves, hydraulic jumps, Stokes Law

Prepared by P. Jewell, 5/2015
GEO 5385 Introduction to Groundwater Modeling

Instructor: D. Kip Solomon

Credits: 1 credit

Text Book: No textbook. Instructor supplied notes and assignments

Course information:

Catalog description: Fundamentals of groundwater flow and transport modeling are introduced in the computer laboratory using hands-on exercises performed with the Groundwater Modeling System (GMS) and the U.S.G.S. groundwater models MODFLOW, MODPATH, and MT3D. By the end of the 5-week course, each student will understand the assumptions and limitations of the modeling approach and will be able to create, run and interpret the results of 2-D groundwater flow and transport simulations using GMS. Topics covered include: defining mathematical/numerical equivalents to real world problems, finite difference method, finite element method and sensitivity studies.

Prerequisites: GEO 5350 or equivalent. Corequisite: GEO 5390.

Required for the Geological Engineering Program:

Course Goals:

Outcomes of instruction: This 5-session course prepares students for completing groundwater modeling assignments in other groundwater courses offered by Geology & Geophysics (e.g., GEO 5380 and 5390). Each 4-hour session comprises a lecture and hands-on computer laboratory use of the Groundwater Modeling System (GMS) software. Lectures outline how groundwater models can be applied, and potentially misused, in scientific and engineering studies.

Contribution of the course to meeting the professional component: This course contributes 1 credit of math and basic science to the geological engineering curriculum.

Student outcome addressed by this course: b) an ability to design and conduct experiments, as well as to analyze and interpret data. k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Topics covered: The mathematical and numerical underpinnings of the finite difference and finite element methods are briefly outlined and compared. Repetitive, hands-on, use of the software in various modes helps to develop facility with GMS and with the core tasks involved in groundwater modeling studies as they are carried out in engineering practice (developing a valid conceptual model, identifying the mathematical boundary value
problem, setting up the numerical modeling software, performing appropriately designed sensitivity studies, and interpreting the modeling results).

*Prepared* by D. K. Solomon, 3/2015
GEO 5390 Solute Transport and Subsurface Remediation

**Instructor:** Dr. William P. Johnson, FASB 441, 1-5033

**Credit hours:** 3 credits

**Textbook:** Instructor organized course materials: multiple texts

**Course information**

**Catalog description:** Application of principles of ground-water hydrology and contaminant chemistry in the remediation of subsurface hazardous waste. Topics include: environmental regulations, toxicology, air-stripping, carbon adsorption, soil vapor extraction, surfactant enhanced extraction, bio-venting, bio-augmentation, solidification, and capture. Class project involves design of remediation system for a hypothetical site. Meets with GEO 6390, 7390.

**Prerequisite(s):** (Non-Geological Engineering majors lacking some of these pre-requisites may enroll with consent of instructor): GEO 3080, GEO 3090; GEO 3400; GEO 5350; GEO 5360; **Co- or pre-requisites:** GEO 5385 (Groundwater Modeling) (should be taken simultaneously to GEO 5390) GEO 5550 (Numerical Methods)

**Required** for the Geological Engineering degree program. This course contributes 3 engineering design credits to the geological engineering curriculum.

**Course goals:**

**Outcomes of instruction:** Develop knowledge of solute fate and transport and interactions, impacts of hydrosphere-anthrosphere interactions. Students will enhance their comprehension and skill in observing, collecting, interpreting and hypothesis testing related to: 4-D (spatial and temporal) interpretation; use of databases and worksheets; numerical modeling related to groundwater flow and solute transport; interpretation of history and significance related to solute transport; design numerical experiments and conduct hypothesis testing related to solute transport and subsurface remediation. Enhance quantification skills related to application of mass balance; application of partial differential equations. Students will enhance skills related to complexity; specifically: design of a system to meet desired needs in the arena of subsurface remediation. Students will enhance ability to articulate in written reports. Students will enhance their knowledge and skills toward professional practice by enhancing their ability to work on teams.

**Contribution of the course to meeting the professional component:** This course contributes 3 credits of engineering topics to the geological engineering curriculum.

**Student outcome addressed by this course:** b) an ability to design and conduct experiments, as well as to analyze and interpret data. c) an ability to design a system, component, or process to meet desired needs. d) an ability to function on multi-disciplinary teams. e) an
ability to identify, formulate, and solve engineering problems. f) an understanding of professional and ethical responsibility. g) an ability to communicate effectively. h) the broad education necessary to understand the impact of engineering solutions in a global and societal context. j) a knowledge of contemporary issues.

Topics covered: The course represents design application of principles mastered in groundwater hydrology, chemical hydrogeology, environmental chemistry and related courses. Topics include: air-stripping, soil vapor extraction, chemical extraction, bioremediation, natural attenuation, and solidification. Teams will be formed to develop a remedial system for a contaminated site. GMS training will be provided in a co-requisite course in groundwater modeling. Topics include: contaminant chemistry, distribution of dense non-aqueous liquids in porous media, contaminant cleanup standards, contaminant fate and transport, contaminant transport modeling, design of pump and treat systems, design of air-strippers, biodegradation parameters, reactive contaminant transport modeling, design of soil vapor extraction systems, solidification and containment systems, parameters for design of solubilization and mobilization systems (surfactant based), design parameters for air sparging systems, passive treatment barriers.

Prepared by: W.P. Johnson, 05/12/2015
GEO 5560 Numerical Methods in the Geosciences

Instructor: W.P. Johnson, FASB 441, Contact: Phone: 1-5033; e-mail: william.johnson@utah.edu

Credit hours: 3 semester credits


Course information:

Catalog description: Application of common numerical methods to problems in geology, hydrology, and geochemistry. Topics include error analysis, roots of equations, solution of differential equations, and finite difference methods.

Suggested prerequisites: None

Required for the geological engineering curriculum.

Course goals:

Outcomes of instruction

1. Learn to use numerical methods to test hypotheses related to data.
2. Develop systems of equations to describe physico-chemical processes and to solve those equations numerically to test hypotheses related to the data.
3. Become better equipped to perform hypothesis testing by developing governing equations for a system and solving them numerically
4. An ability to apply knowledge of mathematics, science, and engineering
5. An ability to design and conduct experiments, as well as to analyze and interpret data
6. An ability to identify, formulate, and solve engineering problems
7. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Contribution of course to meeting the professional component: This course contributes 3 credits of math and basic science to the geological engineering curriculum.

Student outcome addressed by this course: a) an ability to apply knowledge of mathematics, science, and engineering. f) an understanding of professional and ethical responsibility. h) the broad education necessary to understand the impact of engineering solutions in a global and societal context

Topics covered: Errors, roots bracketing, roots open methods, optimization, linear algebra, Gauss elimination, LU, factorization, matrix inversion, iterative methods, eigenvalues, initial value problems, adaptive methods, boundary value problems, linear regression, least squares and
non-linear regression, numerical integration, numerical differentiation.

*Prepared* by P. Jewell, 6/2015
GEO 5760: Stratigraphy and Sedimentary Processes

Instructor: Marjorie Chan

Credit hours: 4 semester hours

Catalog description: Sedimentary processes that erode, transport, and deposit sediments; characteristics and origins of sedimentary rocks; and principles of stratigraphy. Field trips required. Three lectures, one discussion weekly.

Textbook(s) and/or other required material: No required text but many outside readings, websites, and video assignments.

Course information:

Catalog description: Sedimentary processes that erode, transport, and deposit sediments; characteristics and origins of sedimentary rocks; and principles of stratigraphy. Field trips required.

Prerequisite(s): GEO 3090. Recommended Prerequisite: GEO 3060.

Required by geological engineering program

Course goals:

Outcomes of instruction: The course covers principles of sedimentation and stratigraphy, supplemented with field and laboratory exercises. The course starts off with the basics of sedimentary processes and petrology, and then scales up to broader concepts of sedimentation and depositional environments, culminating in stratigraphy, regional to global correlations and basinal analysis. At each step, there are weekly exercises used to reinforce theoretical concepts with hand samples, and field and laboratory examples.

Several important field and laboratory exercises combine geological engineering and science and rely heavily on engineering design for real applications.

1. Well log and lithofacies correlation exercises show students the range of potential interpretations, and offer them the creativity of choosing relevant units.

2. Two field trip exercises show students basic examples of depositional environments, with a focus on how they would interpret rock units on local to regional scales. There is an optional trip to Antelope Island to introduce students to modern environments in the Great Salt Lake. One full-day field trip to the Cretaceous Book Cliffs of Utah exposes the students to clastic facies and the evaluation of coal resources (significance, extent and location of the coal layers) and deltaic analogs of oil and gas reservoirs (analogous to reservoirs in the Gulf Coast). This field trip is similar to the trips that many major oil companies and the American Association of Petroleum Geologists lead for their geologists and engineers. This helps students gain a grasp of reservoir geometries and
heterogeneities. On field trips students work in teams and learn how to interact and cooperate to achieve a good end product.

3. An engineering design exercise on subsurface cores through the Cretaceous Ferron Sandstone of central Utah builds on experiences from the field trips and shows similar deltaic facies in cores. Students are offered the challenge of a real world problem correlating the cores with subsurface well log data, determining which are reservoir vs. source rocks, and examining the reservoir heterogeneities likely to be encountered.

4. The final, end-of-semester, laboratory project is an exploration and reservoir engineering problem that builds on all the concepts that have been previously presented in the course, while offering the challenge of an open-ended, real-world problem. Students are given the objective to propose a drilling site. They are given basic data (a combination of lithologic and well log data), maps, potential information they can “buy” and a budget. Students then analyze and synthesize the data, determine an exploration target with good reservoir quality, and write up a report to support their drilling proposal. The engineering design in this problem requires that students devise a process to evaluate data, make a decision based on the data, and give their reasoning for their predictions. This problem further draws on realistic constraints, risk and economic factors of drilling, and considerations of land use and public issues. The final project fully involves the basic sciences, mathematics and engineering to evaluate resources and optimally to meet a stated drilling objective. Students must write reports to emphasize the importance of good written communication, essential for success in engineering and science.

**Contribution of course to meeting the professional component:** This course contributes 3 credits of basic science, 1 credit of engineering topics to the geological engineering curriculum

**Student outcome addressed by this course:** e) an ability to identify, formulate, and solve engineering problems

**Topics covered:** Stratigraphic Principles, weathering, textures, grain size, classification, porosity-permeability, diagenesis, sedimentary structures, facies, non-marine environments, transitional environments, marine environments, carbonate environments, evaporites, ironstones, chert, volcanics, Phosphates, coal, petroleum, reservoir engineering, unconventional resources, subsurface methods, stratigraphic sections, lithostratigraphic units, lithologic correlations, stratigraphic Interpretations, unconformities, paleogeography, eustasy, seismic stratigraphy, GPR, sequence stratigraphy, magnetostratigraphy, oceans, biostratigraphy, chemostratigraphy, modeling, plate tectonics, rift basins, convergent margins, craton, petrofacies, basin analysis, paleoclimate, global cycles, hot topics future trends

**Prepared by:** M.A. Chan, re-arranged by P. W. Jewell, 3/15
CVEEN 2010: Statics

Credit hours: 2 semester hours

Textbooks and/or other required material: Bedford and Fowler, *Engineering Mechanics, Statics, Fifth Edition*

Course information:

General Catalog Course Description: Forces, moments and couples; resultants and static equilibrium of general force systems; statically equivalent force systems, center of gravity and center of pressure; friction; free body method of analysis; trusses and frames; internal forces (shear forces and bending moments); tensile and compressive axial forces; application to simple engineering problems.

Prerequisites: MATH 1210

Required for the geological engineering curriculum

Course goals:

Course Learning Outcomes:

1. Application of vectors to systems of forces and moments
2. Application of equilibrium concepts and the free-body diagram to simple static structures
3. Comprehension of centroid and area moment of inertia concepts as used in statics
4. Comprehension of internal forces and moments in static beams, and related to liquids and gasses
5. Knowledge of the theory of dry friction, with simple applications to wedges and belt friction

Contribution to the professional component: This course contributes 3 credits of math and basic science to the geological engineering curriculum.

Topics covered in the course:

1. Course introduction and vector operations
2. Forces and free-body diagrams
3. Moments, couples, and equivalent systems
4. Equilibrium
5. Trusses, frames, and machines
6. Centroids, distributed loads, and introduction to centers of mass
7. Moments of inertia
8. Beams
9. Pressure loading
10. Friction
11. Additionally, there are three mid-term examinations and review sessions for two of these exams and the final exam. Safety case studies are presented in conjunction with two of the review sessions.
CVEEN 3310 – Geotechnical Engineering

**Instructor:** Steven F. Bartlett

**Credits and contact hours:** 3 semester credits


**Course information**

**Catalog Description:** An introduction to the fundamental geologic and engineering properties of soils and basic soil mechanics. Topics include geologic soil processes, phase relations, grain-size distribution, clay mineralogy, clay-water interaction, consistency limits, fabric and structure, classification, compaction, swelling, shrinkage, slaking, collapse, permeability, one-and two-dimensional flow, liquefaction, consolidation and settlement, and shearing strength of cohesionless soils.

**Prerequisite(s):** CVEEN 2140 – Strength of Materials

**Required for the Geological Engineering Curriculum**

**Course goals**

**Outcomes of instruction**

1. Understand how geologic processes form soil deposits.
2. Gain knowledge of soil as a geotechnical material.
3. Understand how to help foster and develop the engineering judgment required to practice geotechnical engineering.
4. Understand index and classification properties of soils.
5. Apply this knowledge to the soil classification.
6. Understand clay mineral and the structure and how this structure affects their properties.
7. Understand compaction and how to apply it to relative compaction.
8. Understand other soil-water interactions (i.e., capillarity, shrinkage, swelling, frost action).
9. Understand, apply and analyze topics related to seepage, effective stress, consolidation and time rate of consolidation.

**Contribution to the professional component:** This course contributes 3 credits of math and basic science to the geological engineering curriculum.
**Student outcomes addressed by this course:**

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Role of CVEEN 3310</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) an ability to apply knowledge of mathematics, science, and engineering</td>
<td>Homework, quizzes, and exams teach principles of solving 1 and 2-D flow equations by using examples of flow nets and consolidation calculations. These principles are taught and reinforced at the application level by applied problems.</td>
</tr>
<tr>
<td>(b) an ability to design and conduct experiments, as well as to analyze and interpret data</td>
<td>The lecture and laboratory component of this course emphasize the conducting of a series of experiments designed to teach principles of geotechnical engineering. Each student group is expected to perform a series of experiments, evaluate the obtained data, including using statistical techniques and interpret the results in a laboratory report.</td>
</tr>
<tr>
<td>(e) an ability to identify, formulate, and solve engineering problems</td>
<td>The students are expected to solve applied problems dealing with consolidation theory and its application to settlement of embankment and footings. This involves interpretation of laboratory data, understanding soil loadings, and calculating the subsequent consolidation settlement.</td>
</tr>
</tbody>
</table>

**Topics covered:**

1. Geologic soil processes
2. Phase relations
3. Grain-size distribution
4. Clay mineralogy
5. Clay-water interaction
6. Consistency limits
7. Soil fabric and structure
8. Soil classification
9. Compaction
10. Swelling, shrinkage, slaking, collapse
11. Permeability
12. One- and two-dimensional flow
13. Liquefaction
14. Consolidation and settlement
15. Shear strength of cohesionless soils

Prepared by: Steven F. Bartlett, December 2014
CVEEN 5305 – Introduction to Foundation Engineering

Credits hours: 3 semester hours: two 80-minutes classes per week

Instructor: Steven F. Bartlett


Specific course information

Catalog Description: Meets with CVEEN 6305. An introduction to the field of foundation engineering concentrating on the geotechnical background necessary for foundation analysis and design. Topics include shear strength of granular, cohesive and partially saturated soils; subsurface exploration and testing; lateral earth pressures and retaining walls; slope stability; settlement and ultimate bearing capacity of shallow foundations; seepage forces and filters.

Prerequisite(s):
C- or better in CVEEN 3310 (Introduction to Geotechnical Engineering AND Full Major status in Civil Engineering.

Specific goals for the course

Outcomes of instruction
Evaluate strength of soil from common geotechnical laboratory and in situ tests
Understand how shear strength affects the design of geotechnical structures
Learn how to obtain shear strength parameters from in situ tests
Perform bearing capacity and settlement calculations for shallow foundations
Calculate lateral earth pressures for buried structures
Assess stability of retaining walls
Evaluate slope stability for simple slopes

Contribution to the professional component: This course contributes 3 credits of math and basic science to the geological engineering curriculum.
### Student outcomes addressed by this course:

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Role of CVEEN 5305</th>
</tr>
</thead>
<tbody>
<tr>
<td>(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability</td>
<td>CVEEN 5305 focuses on the theory and calculation methods required to design shallow foundation and footings, earth retaining structures and slopes. The design of shallow foundations is achieved through the application of bearing capacity theory to the evaluation of footings. The design of earth retaining structures is achieved through the application of bearing capacity theory to the evaluation of retaining walls, and the evaluation and design of embankments and engineered slopes is obtained through the application of general shear strength theory and method of slices to the evaluation of embankments and slopes.</td>
</tr>
</tbody>
</table>

### Topics:

- Coulomb failure theory for soils, factor of safety
- Direct shear and triaxial shear strength tests, stress paths
- Stress-strain-strength characteristics of cohesionless soil
- Ko conditions in cohesionless soil
- Stress-strain-strength characteristics of cohesive soil
- Consolidated Drained (CD) strength behavior of cohesive soil
- Consolidated Undrained (CU) strength behavior of cohesive soil
- Unconsolidated Undrained (UU) strength behavior of cohesive soil
- CD, CU, UU Stress paths
- Ko for clays, Skempton Pore Pressure Parameters
- Subsurface investigation: Exploration and sampling
- Standard Penetration Test (SPT) and correlation
- Cone Penetration Test (CPT) and correlations
- Borehole Shear Test (BST)
- Introduction to foundations, settlement of granular soils
- Schmertmann's method (continued), intro bearing capacity
- Ultimate BC: Terzaghi's method, Meyerhof's method
- Lateral earth pressures: At-rest, active, passive; Rankine, Columb
- Equivalent fluid pressure, effect of E/Q loads
- Slope stability: Factor of safety, infinite slopes, finite slopes
- Slope stability: Finite slopes in sands and saturated clays
- Slope stability: Slice methods (method of slices)

Prepared by: Steven F. Bartlett, December 2014
MG EN 1050 -- TECHNICAL COMMUNICATIONS

Credit hours: 2 semester hours

Textbook: AutoCAD 2010 / AutoCAD LT 2010: Essentials AOTC Autodesk, Inc., San Rafael, CA 94903

Course information:

Catalog Description: Elements of communication in an engineering setting. Introduction to drafting techniques using engineering standards and software, including CAD software. Course includes semester design project and presentation with an emphasis on intra-software communication.

Prerequisite(s): None

Required for the Geological Engineering Curriculum

Course goals:

Objectives of instruction: Develop skill in using AutoCAD to communicate technical information graphically. Use PowerPoint in making a presentation. Understand function of scale and dimensions on drawings. Learn design skills in AutoCAD. Use AutoCAD and PowerPoint to complete design project.

Contribution to the professional component: This course contributes 3 credits of engineering topics to the geological engineering curriculum.


Design Projects: Determine the location of a road subject to grade and curvature restrictions.
Topographic base, starting road and end location are provided by instructor. Hard copy and presentation required
MG 2400   INTRODUCTORY SURVEYING

**Instructor:** Dana Johnson, 313 Browning Bldg.

**Credit hours:** 3 semester hours

**Text:** Moffitt, F. H. and J. D. Bossler, *Surveying*, 10th Edition, Addison-Wesley (This text book is recommended but not required. You may also be interested in a Schaum’s Outline on Introductory Surveying. It can be ordered from Amazon.com for about $19. This is not required but contains worked problems. Copies of Moffitt and Bossler are at the Mining Dept. library for your use in the library - cannot be checked out without permission.

**Course information:**

**Catalog Description.** Use of level, total station, GPS, and other equipment in field surveying. Practical astronomy, calculation procedures, state plane coordinates, public land division and introduction to Global Position Systems (GPS) and Geographic Information Systems (GIS). Field demonstration and use of surveying equipment illustrate concepts presented in lecture. Laboratory fee assessed.

**Prerequisites:** Trigonometry, Math 1060 or equivalent. MG EN 1050 or equivalent course in ACAD HIGHLY recommended.

**Required** for the Geological Engineering Curriculum

**Course goals**

**Outcomes of instruction:** Students will be required to

1) Calculate location of points in space (coordinates and elevation).
2) Calculate cuts and fills for earth moving projects.
3) Determine the direction of lines from astronomical observations and state plane and UTM coordinates.
4) Design horizontal curves for road construction.
5) Compare relative merits of various surveying techniques.
6) Demonstrate discipline and consistency in data computations.
7) Improve report-writing skills and clearly and neatly document field work

**Contribution to the professional component:** This course contributes 3 credits of math and basic science to the geological engineering curriculum.


**Topics covered:**

Course objectives include improving student skills in:

1) Applying knowledge of mathematics to solve practical problems related to surveying.
2) Analyzing data from field measurements and related calculations.
3) Functioning on teams where team members have different tasks to perform.
4) Formulating and solving engineering problems related to location and orientation on the surface of the earth, land use, measurement of areas and volumes, earth moving projects, and road construction.
5) Communicating effectively in writing and graphical representation.
6) Using traditional and current engineering tools such as levels, total stations, GPS and computer methods for computations and data presentation.
MG EN 5150 – Mechanics of Materials

Credit hours: 3 semester credits


Required Notes: ISRM and ASTM standards (class notes).

Course information:

Catalog description: Concepts of stress and strain, Hooke’s law, torsion of circular bars, bending shear and deflection of beams, biaxial stress and Mohr’s circle, strength of materials. Laboratory testing for material properties, report writing. Emphasis on rock and soil. Laboratory fee assessed.

Prerequisites: PHYCS 2220, MATH 2250, CVEEN 2010

Required for the Geological Engineering Curriculum

Course goals

Objectives of instruction
1. Understand the overall mathematical structure of mechanics of materials.
2. Understand the concept of stress and the distinction between normal and shear stress.
3. Understand the concept of strain including normal and shear strains.
4. Understand stress-strain relations, especially Hooke’s law (elasticity).
5. Be able to refer stress and strain to rotated reference axes.
6. Be able to calculate stress, strain and displacement in axially loaded structures.
7. Be able to calculate stress, strain and displacement in round bars subject to torsion.
8. Be able to construct moment and shear diagrams for beams.
9. Be able to solve elementary beam problems for stress, strain and displacement.
10. Be able to calculate buckling loads for slender columns.
11. Understand the concept of stress concentration about notches, corners and holes.
12. Understand strength and failure criteria for a variety of ductile and brittle materials.
13. Be able to apply the concepts of allowable stress and factor of safety to design of structures.
14. Understand bonded resistance strain gauges.
15. Be able to conduct laboratory tests for elastic and strength properties.
16. Understand index properties of geologic media.
17. Be able to write effective laboratory reports using figures and tables according to accepted standards.

Required for the Geological Engineering Curriculum

Topics covered
1. Class organization, syllabus, outline, standards.
2. Equilibrium, forces, moments, axial load.
3. Laboratory sample preparation.
5. Stress transformation, plane stress.
Mohr’s Circle
7. Concept of strain, normal strain, shear strain
8. Strain transformation, plane strain.
9. Material properties.
10. Displacement calibration experiment.
11. Stress-strain laws, Hooke’s law.
12. Axial load, normal stress and strain
13. Limits to elasticity, rock failure
14. Elastic moduli experiments 1, 2.
15. Torsion, shear stress and strain.
16. Torque, twist, power.
17. Beams, shear and moment diagrams.
18. Tensile strength experiment.
20. Beams, shear stress in beams.
22. Beam deflection.
23. Compressive strength under confining press.
25. Direct shear test - sand.
26. Direct shear test - joint
MG EN 5160 – Applied Rock Mechanics

Credit hours: 3 semester credits


Course information

Catalog description: Concepts of stress and strain, Hooke’s law, torsion of circular bars, bending shear and deflection of beams, biaxial stress and Mohr’s circle, strength of materials. Laboratory testing for material properties, report writing. Emphasis on rock and soil. Laboratory fee assessed.

Prerequisites: MATH 2250, MG EN 5150.

Required for the Geological Engineering Curriculum

Course goals:

Outcomes of instruction

1. Understand the fundamentals of estimating rock mass motion.
2. Be able to estimate naturally supported safety factors of shafts and tunnels.
3. Be able to estimate circular concrete liner support thickness required.
4. Be able to calculate steel set size and spacing required for a given tunnel site.
5. Be able to apply beam theory to naturally support roof in stratified ground.
6. Be able to design a roof bolt system when beam action occurs.
7. Understand the role of wire mesh, screen, chain link and membranes.
8. Be able to specify pillar size to meet a specified safety factor requirement.
9. Be able to calculate pillar safety factors in the presence of joints.
10. Understand the characteristics of mine backfills and fill types.
11. Be able to use a dead weight load approach to cable bolt system design.
12. Be able to calculate cave height and surface subsidence under chimney caves.
13. Be able to design combination support systems in caving ground.
14. Be able to estimate surface trough subsidence, strain profiles and structure damage over mines in stratified ground.
15. Understand the mechanics of planar block and wedge slides including the role of water, seismic forces, surcharges, reinforcement bolting, tension cracks.
16. Be able to calculate translational slide safety factors and remedial measure.
17. Be able to calculate rotational slide safety factors by the method of slices.

Contribution to the professional component: This course contributes 3 credits of engineering topics to the geological engineering curriculum.

Topics covered

1. Objectives of rock mechanics, overall approach.
2. Review of fundamentals, physical laws, kinematics, material models.
3. Stress, strain, Hooke’s law, stress-strain relationships.
4. Rock strength, intact rock, joint and jointed rock, effective stress.
5. Initial stress, stress change and applied loads.
6. Factor of safety approach to elastic design.
8. Water pressure, water forces. Rock slope failures.
9. Seismic forces, surcharge, reinforcement, computer program.
10. Wedge failures. Wedge failure computer program.
12. Toppling failures.
13. Computer program for rotational failures
14. Stress concentration data (2D), hole shape, aspect ratio, orientation, number, spacing.
Stress concentration data (3D).
15. Rock mass classification systems for rock engineering.
18. Tunnel bolting and rock mass reinforcement, equivalence to steel sets.
20. Support mechanisms, bed separation analysis, factor of safety calculation.
22. Post-tensioned, distributed anchorage bolts, resin bolts, grouted rebar.
23. Friction bolts, split sets, roof trusses, mats, chain-link, wire mesh, screens.
24. Dead weight load design. Case study of bed separation and roof beam action.
25. Tributary area concept, extraction ratio pillar design approach in flat seams.
27. Hardrock mine pillars, stope support.
29. Chimney caving kinematics, bulking porosity.
30. Chimney forces. Support combinations in caving ground.
31. Bolting and shotcrete reinforcement against joint slip.
32. Subsidence over tabular excavations in stratified ground.
33. Trough subsidence, subsidence profile calculation.
CHEM 1210 : General Chemistry I

Credit hours: 4 credits

Cengage Learning OWL access

Course Information:

Catalog Description: Fundamentals of chemistry emphasizing descriptive and modern applied chemistry for science and engineering majors. Topics include atomic theory, molecular bonding, and reaction chemistry.

Prerequisites: CHEM 1200, or MATH 1050 or equivalent, or placement.

Required for the Geological Engineering Curriculum

Topics covered:

1. Chemical foundations
2. Atomic structure and periodicity
3. Atoms to molecules
4. Bonding: general concepts
5. Molecular structure and orbitals
6. Chemical energy
7. Gases
8. Liquids and solids
9. Stoichiometry
10. Types of chemical reactions and solution stoichiometry

Contribution of course to meeting the professional component: 4 credits of basic math and science

CHEM 1215 : General Chemistry Laboratory I

Credit hours: 1 semester credit hour

Course information:

General Catalog Course Description: One lecture and one 3 hour lab per week. Must be taken concurrently with CHEM 1210.

Prerequisites: N/A

Text: Chemistry 1215 lab manual, Experiments in General Chemistry Featuring MeasureNet®, 2nd edition

Course goals:

Outcomes of instruction:
1. Enhance your understanding of core general chemistry concepts through hands-on, tangible laboratory experiments (This course should be taken concurrently with CHEM 1210)
2. Introduce you to common laboratory techniques and safe laboratory practices

Required for the Geological Engineering Curriculum

Contribution of course to meeting the professional component: This course contributes 1 credit of math and basic science to the geological engineering curriculum.

CHEM 1220 General Chemistry II

Credit hours: 4 semester credit hours

Text: Zumdahl and Zumdahl, Chemistry an Atom's First Approach, 1st edition

Course information:

General Catalog Course Description: Chemistry 1220 is a four-credit course that consists of three lectures (sections 1 and 4) per week. Chemistry 1225 is the companion one-credit lab course. Chemistry 1225 meets one three-hour period per week. CHEM 1220/1225 are general chemistry courses that are comparable to any science majors’ sequence taught at major state universities in the United States. As a student, you are expected to perform at a level that is commensurate with students from other institutions such as Pennsylvania State University, University of Arizona, University of Wisconsin-Madison, and University of California-Berkeley. We expect excellence from you as well as from ourselves.

Prerequisites: N/A

Required for the Geological Engineering Curriculum

Course goals

Outcomes of instruction:

- Understanding the time, length, and energy scales on which chemical processes occur
- Understanding the differences between classical and quantum mechanics
- Connecting operators to observables
- Distinguishing probabilities, amplitudes, averages, expectation values, and observables
- Understanding the origin and implications of quantum coherence
- Interpreting spectra
- Connecting common approximation methods to standard chemical frameworks (Born-Oppenheimer, molecular orbitals)
- Developing molecular-level critical thinking skills

Contribution of course to meeting the professional component: This course contributes 4 credits of math and basic science to the geological engineering curriculum.
Topics covered:

1. Solids, Liquids, Phase Changes
2. Properties of Solutions
3. Chemical Kinetics
4. The Nucleus: A Chemist’s View
5. Chemical Equilibrium
6. Acids and Bases
7. Acid-Base Equilibria
8. Solubility and Complex Ion Equilibria
9. Spontaneity, Entropy, and Free Energy
10. Electrochemistry
11.

CHEM 1225: General Chemistry Laboratory II

**Credit hours:** 1 credit hour  
**Text:** Chemistry 1225 lab manual *Experiments in General Chemistry Featuring MeasureNet, 2nd edition*

**Course information:**

*General Catalog Course Description:* One lecture per week, one three-hour laboratory/discussion per week. (Must be taken concurrently with Chem. 1220.)  

**Prerequisites:** N/A  

**Required** for the Geological Engineering Curriculum

**Course goals**

**Outcomes of instruction:**

1) Enhance your understanding of core general chemistry concepts through hands-on, tangible laboratory experiments (This course should be taken concurrently with CHEM 1220)  
2) Introduce you to common laboratory techniques and safe laboratory practices

**Contribution of course to meeting the professional component:** This course contributes 1 credit of math and basic science to the geological engineering curriculum.

**Prepared by:** Alexis Ulrich **Date:** 4/22/15; **modified by P. W. Jewell, June 14, 2015**
MATH 1210: Calculus I

**Credit hours:** 4 semester credit hours

**Text:** Varberg, Purcell, & Ridgon, *Calculus with Differential Equations, 9th edition*

**Course information:**

**General Catalog Course Description:** Functions and their graphs, differentiation of polynomial, rational and trigonometric functions. Velocity and acceleration. Geometric applications of the derivative, minimization and maximization problems, the indefinite integral, and an introduction to differential equations. The definite integral and the Fundamental Theorem of Calculus.

**Prerequisites:** MATH 1050 & 1060, or MATH 1080

**Required** for the Geological Engineering Curriculum

**Course information:**

**Outcomes of instruction:**

- Take limits of algebraic and trigonometric expressions of the form 0/0 (that simplify), non-zero number over 0, including limits that go to (positive or negative) infinity, limits that don't exist and limits that are finite.
- Use the limit definitions of derivative and definite integral for polynomial, rational and some trigonometric functions; understand definition of continuity.
- Differentiate all polynomial, rational, radical, and trigonometric functions and compositions of those functions; perform implicit differentiation and compute higher order derivatives.
- Use differentiation to find stationary, singular and inflection points, as well as domain and limit information to determine vertical and horizontal asymptotes, and then use all of that information to sketch the graph of a curve, \( y = f(x) \).
- Apply differentiation to optimization and related rates problems.
- Compute indefinite and definite integrals, using the power rule and basic u-substitution and the Fundamental Theorems of Calculus.
- Apply the definite integral to compute area between two curves, volumes of solids of revolutions, arc length, surface area for surfaces of revolution and center of mass.

**Contribution of course to meeting the professional component:** This course contributes 4 credits of math and basic science to the geological engineering curriculum.
Topics covered:

1. Functions and their graphs, differentiation of polynomial, rational and trigonometric functions

2. Velocity and acceleration

3. Geometric applications of the derivative, minimization and maximization problems, the indefinite integral, and an introduction to differential equations

4. The definite integral and the Fundamental Theorem of Calculus.

MATH 1220, Calculus II

**Credit hours:** 4 semester credit hours

**Text:** Varberg, Purcell, & Rigdon, *Calculus with Differential Equations, 9th edition* Rigdon, *Student Solutions Manual for Calculus*

**Course information:**

*General Catalog Course Description:* Geometric applications of the integral, logarithmic, and exponential functions, techniques of integration, conic sections, improper integrals, numerical approximation techniques, infinite series and power series expansions, differential equations (continued).

*Prerequisites:* MATH 1210 or equivalent

*Required* for the Geological Engineering Curriculum

**Course goals**

*Outcomes of instruction:*

- Compute derivatives and integrals for exponential, logarithmic, hyperbolic functions, and inverse trigonometric functions
- Integrate integrable functions using integration by parts, u-substitution, trigonometric substitutions, rationalizing substitutions, partial fraction decomposition, and trigonometric identities. This includes knowing which techniques to apply to a given integral
- Use L’Hopital’s Rule to calculate indeterminate-type limits and also know what limits are the non-indeterminate forms and how to compute those limits
- Compute improper integrals
- Understand the difference between an infinite sequence and infinite series and determine if a sequence converges or diverges
- Determine whether or not an infinite series of numbers converges or diverges using a variety of tests
- Understand what it means for a Power Series to converge or diverge and be able to find the Taylor Series for a given function
- Differentiate and integrate functions in polar coordinates

*Contribution of course to meeting the professional component:* This course contributes 4 credits of math and basic science to the geological engineering curriculum.

**Topics covered in the course:**

1. Transcendental Functions
2. Techniques of Integration
3. Indeterminate forms and improper integrals
4. Infinite Series
5. Conics & Polar Coordinates

*Prepared by:* Alexis Ulrich *Date:* 3/23; *modified by P. W. Jewell, June 14, 2015*
MATH 2210, Calculus III

Credit hours: 3 semester hours
Text: Varberg, Purcell, and Rigdon, *Calculus with Differential Equations, 9th edition*

Course information:

**General Catalog Course Description:** Vectors in the plane and in 3-space, differential calculus in several variables, integration and its applications in several variables, vector fields and line, surface, and volume integrals. Green's and Stokes' theorems.

**Prerequisites:** MATH 1220 or equivalent

**Required** for the Geological Engineering Curriculum

Course goals:

**Outcomes of instruction:**

- Compute dot and cross products of two vectors, projection of one vector onto another vector.
- Convert between cylindrical, rectangular and spherical coordinates.
- Determine the equation of a plane in 3D, including a tangent plane to a surface in 3D.
- Find the parametric equations of a line in 3D.
- Perform calculus operations on functions of several variables, including limits, partial derivatives, directional derivatives, and gradients; understand what the gradient means geometrically.
- Find maxima and minima of a function of two variables; use Lagrange Multipliers for constrained optimization problems.
- Compute double and triple integrals in rectangular, spherical and cylindrical coordinates; proper use of double or triple integrals for finding surface area or volume of a 3D region.
- Compute line and surface integrals.

**Contribution of course to meeting the professional component:** This course contributes 3 credits of math and basic science to the geological engineering curriculum.

Topics covered in the course:

1. Parametric Curves, Three Dimensional Coordinates, Vectors
2. Dot Product, Cross Product
3. Vector Valued Functions, Curvilinear Motion, Three Dimensional Lines and Tangent Lines, Three Dimensional Surfaces
4. Spherical and Cylindrical Coordinates
5. Functions of Several Variables, Partial Derivatives, Limits and Continuity
6. Differentiability, Directional Derivative, Gradients
7. Chain Rule, Tangent Plane, Approximations, Maxima and Minima
8. Lagrange Multipliers
9. Double Integrals, Iterated Integrals, Integration over General Regions
E-15
10. Double Integrals in Polar Coordinates, Surface Area, Triple Integrals
11. Integrals in Cylindrical/Spherical Coordinates, Change of Variables, Jacobian
12. Line Integrals
13. Independence of Path, Green’s Theorem, Surface Integrals
14. Gauss’s Divergence Theorem, Stokes’ Theorem

MATH 2250: Differential Equations and Linear Algebra

Credit hours: 3 semester hours

Edwards, Penny, & Haberman, Linear Algebra and Differential Equations with Introductory Partial Differential Equations and Fourier Series
Edwards and Penney, Elementary Linear Algebra

Course information:

General Catalog Course Description: This is a hybrid course which teaches the allied subjects of linear algebra and differential equations. These topics underpin the mathematics required for most students in the Colleges of Science, Engineering, Mines & Earth Science.

Prerequisites: MATH 1210-1220 (single-variable calculus). Understanding of vectors and parametric curves. Recommended multivariable calculus (MATH 1260 or equivalent) taken prior to this course.

Required for the Geological Engineering Curriculum

Course goals:

Outcomes of instruction:

• Use general principles to model a phenomenon and derive the relevant governing differential equations;
• Learn solution techniques and visualization tools for first order separable and linear differential equations;
• Learn matrix algebra techniques, in order to be able to compute the solution space to linear systems and understand its structure;
• Be able to use the basic concepts of linear algebra such as linear combinations, span, independence, basis and dimension, to understand the solution space to linear equations, linear differential equations, and linear systems of differential equations;
• Understand the natural initial value problems for first order systems of differential equations, and how they encompass the natural initial value problems for higher order differential equations and general systems of differential equations;
• Learn how to solve constant coefficient linear differential equations via superposition, particular solutions, and homogeneous solutions found via characteristic equation analysis;
• Learn how to use Laplace transform techniques to solve linear differential equations;
• Understand the concepts of eigenvalues and eigenvectors and be able to compute them. Apply them to find the general solution space for first and second order constant coefficient homogeneous linear systems of differential equations;
• Understand and be able to use linearization as a technique to study the behavior of nonlinear autonomous dynamical systems near equilibrium solutions;
• Develop your ability to communicate modeling and mathematical explanations and solutions, using technology and software such as Maple, Matlab or internet-based tools as appropriate.

**Contribution of course to meeting the professional component:** This course contributes 3 credits of math and basic science to the geological engineering curriculum.

**Topics covered in the course:**

1. Differential equations, mathematical models, integrals as a general or particular solution, slope field, separable differential equations
2. Linear differential equation, LR and RC circuits, mixture model, population model, cascades, equilibrium solution, stability, acceleration-velocity models
3. Escape velocity, Jules Verne problem, numerical solutions
4. Linear systems, matrices, Gaussian elimination, reduced row echelon form
5. Matrix operations, matrix inverses, determinants
6. Vector spaces, linear combinations in $\mathbb{R}^n$, span and independence, subspaces
7. Bases and dimension, abstract vector spaces and solution space of a DE, second-order linear DE, general solutions, superposition
8. Constant coefficients, mechanical vibrations, pendulum model, particular solutions to non-homogeneous problems, circuits
9. Forced oscillations, resonance and mechanical vibrations, Laplace transforms, solving a DE with transforms
10. Partial fractions and translations, unit step, ramp, convolution, impulse response
11. Eigenvalues and eigenvectors, diagonalization, power method, first-order systems of ODE
12. Matrix systems of DE, eigenanalysis method, spring systems, forced undamped systems
13. Systems and practical resonance, equilibria, stability, phase portraits for non-linear systems
14. Populations and ecological models, nonlinear mechanical systems

PHYS 2210, 2215 Physics for Scientists and Engineers I, Physics for Scientists and Engineers I Laboratory

**Credit hours:** 4 semester hours (PHYS 2210), 1 semester hour (PHYS 2215)

**Textbooks and/or other required material:** Gladding, Selen, and Stelzer, *smartPhysics: Classical Mechanics*

**Course information**

**Catalog Description:**

*Phys 2210:* Three lectures and two recitations weekly. Designed to give science and engineering students a thorough understanding of the basic physical laws and their consequences. Classic mechanics will be introduced, including methods of energy, momentum, angular momentum, and Newtonian gravity. Applications will include mechanical oscillations, sound, and wave motion.

*Phys 2215:* Teaches laboratory skills needed by scientists and engineers. Measurement, data analysis, computer graphics display, experimental design and report writing, experimental procedures and results. Experiments in mechanics and waves. Laboratory designed to accompany PHYS 2210.

**Prerequisites:** MATH 1210

**Required** for the Geological Engineering Curriculum

**Course goals:**

**Outcomes of instruction:**

1. Help students understand and solve problems in a broad range of scientific and engineering fields.
2. Teach students the fundamental principles of physics
3. Teach student how to describe real world phenomena quantitatively
4. Teach problem-solving skills that can be applied to other areas of science, engineering, and life.

**Contribution of course to meeting the professional component:** This course contributes 4 credits of math and basic science to the geological engineering curriculum.

**Topics covered:**

1. Kinematics
2. Dynamics and statics
3. Motion in multiple dimensions
4. Forces and the laws of motion
5. Energy
6. Momentum
7. Rotational Momentum
8. Gravitation
9. Constraints
10. Oscillations and waves

Prepared by: Ajay Nahata
Date: 06/12/2015
PHYS 2220 Physics for Scientists and Engineers II

Credit hours: 4 semester hours

Text: Serway & Jewett, Jr., Physics for Scientists and Engineerins (with Modern Physics), 9th edition

Course information:


Prerequisites: PHYS 2210 and MATH 1110 & 1220

Required for the Geological Engineering Curriculum

Topics covered:

1. Electric fields
2. Electric currents
3. Magnetic fields
4. Induced currents
5. Electromagnetic waves and optics

Contribution of course to meeting the professional component: This course contributes 4 credits of math and basic science to the geological engineering curriculum.

Prepared by: Alexis Ulrich Date: 3/27/15; modified by P. Jewell, 6/14/2015
MET E 3070 – Statistical Methods in Earth Sciences and Engineering

Instructor: Raj K. Rajamani, Professor

Credit Hours: 3 semester hours


Other Required Materials: Class handouts posted on WebCT for students

Course Information

Catalog Description: Probability density functions, fundamental sampling distributions, one and two-sample estimation problems. Selected examples from mining, geology, metallurgy, and meteorology.

Prerequisite(s) Calculus, college algebra. Fulfills quantitative reasoning (Statistics/Logic)

Required for the Geological Engineering Curriculum

Course goals:

Outcomes of instruction: To understand the basic concepts of probability. The course covers probability density functions. Next, with this background, a study of elementary statistics is taken up. The textbook examples, homework problems, and labs focus on applying statistics to real-world situation. The student will emerge from this class with the confidence to apply statistics to their laboratory or field work data.

Contribution to the professional component: This course contributes 3 credits of math and basic science to the geological engineering curriculum.

Topics covered:

1. Introduction to statistics and quality improvement: statistical thinking: understanding and managing variability, variables, types of data, and levels of measurement, sampling, statistical and spreadsheet software, the connection between quality and statistics

2. Tables and charts: process flow diagrams and cause-and-effect diagrams, importance of the time-order plot, tables and charts for numerical data, check sheets and summary tables, concentration diagrams, graphing categorical data, tables and charts for bivariate categorical data

3. Describing and summarizing data: measures of central tendency, variation, and shape, the box-and-whisker plot

4. Probability and discrete probability distributions: the probability distribution, binomial distribution, hypergeometric distribution, negative binomial and geometric distributions, Poisson distribution
5. Continuous probability distributions and sampling distributions: the uniform distribution, the normal distribution, the standard normal distribution as an approximation to the binomial and Poisson distributions, the normal probability plot, the lognormal distribution, exponential distribution, Weibull distribution, sampling distribution of the mean, sampling distribution of the proportion

6. Estimation procedures: properties of estimators, confidence interval estimation of the mean, and variance, tolerance intervals, confidence interval estimation for the proportion

7. Introduction to hypothesis testing: basic concepts of hypothesis-one-sample tests for the mean, t test for the difference between the means of two independent groups, and two variances, the repeated measures of paired t test, chi-square test for the differences among proportions in two or more groups, $\chi^2$ test of hypothesis for the variance or standard deviation.

Prepared by: Raj K. Rajamani Date: March 26, 2015
Appendix B – Faculty Vitae

Paul W. Jewell

Education
1975-1978. B.S. Geology, Beloit College, Beloit, Wisconsin

Academic experience
2014-present. Professor, University of Utah, Teach courses in fluid dynamics, GIS, computer programming, and introductory earth science. Active research program emphasizing the characterization and evolution of earth landforms and surface water.
1996-2014. Associate Professor, University of Utah
1989-1996. Assistant Professor, University of Utah

Non-academic experience
1980-1981. Associate Geologist, University of Utah Research Institute, Salt Lake City, Utah. Responsible for evaluating low-temperature geothermal resources in western United States.

Current membership in professional organizations
Geological Society of America, American Geophysical Union, Association of Engineering Geologists, Society of Economic Geologists, Utah Geological Association

Honors and awards
Faculty Fellow, University of Utah, 1997; American Men and Women of Science, 1994; Chevron Graduate Fellow in Geology, 1982-1983
Service activities

<table>
<thead>
<tr>
<th>Position</th>
<th>Affiliation</th>
<th>Period</th>
</tr>
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<tbody>
<tr>
<td>Annual Meeting Steering Committee</td>
<td>Association of Engineering and Environmental Geologists</td>
<td>2012</td>
</tr>
<tr>
<td>Ad Hoc Technical Advisor for New Museum</td>
<td>Utah Museum of Natural History</td>
<td>2006-2008</td>
</tr>
<tr>
<td>Program Evaluator</td>
<td>American Board of Engineering and Technology (ABET)</td>
<td>2004 - present</td>
</tr>
<tr>
<td>Chair, Education Committee</td>
<td>Utah Geological Association</td>
<td>2003 - present</td>
</tr>
</tbody>
</table>

Important publications (past 5 years)


Recent professional development activities

- Education Outreach Chair, Utah Geological Association (2003-present). Responsible for coordinating outreach activities to K-12 schools in the Salt Lake area.
- Ad Hoc consultant on water resource issues, Friends of the Great Salt Lake, 2009-present
Douglas Kip Solomon

Education

Academic experience
2009-2013. Chair, Department of Geology and Geophysics, University of Utah
2003-present. Professor, University of Utah, Teach courses in groundwater hydrology, solute transport, environmental geology, and general geology. Active research program emphasizing the use of tracers for evaluating hydrologic processes.
1997-2003. Associate Professor, University of Utah
1993-1997. Assistant Professor, University of Utah

Non-academic experience

Current membership in professional organizations
American Geophysical Union; Geological Society of America, Hydrogeology Division Program Chair

Honors and awards
-2009 Adrian Smith Lecturer in Geochemistry, University of Waterloo
-OCE Distinguished Visiting Scientist, CSIRO Division of Land and Water, Australia, 2008.
-2005 Darcy Lecturer of National Ground Water Association.
- Outstanding Faculty Teaching, College Mines Earth Sciences, University of Utah, 2001-02.
- Outstanding Faculty Research, Dept. Geology & Geophysics, University of Utah, 1997-98.
- Outstanding Faculty Teaching, Dept. Geology & Geophysics, University of Utah, 1996-97.

Service activities
Invited participant, NSF All Hands CZO Workshop, May 2011.
Invited participant, DOE Workshop on Basic Research Needs in Geosciences, Feb., 2007, Bethesda MA.

Important publications (past 5 years)

Recent professional development activities
Appointed to Birdsall-Dreiss Distinguished Lectureship Committee, 2013
Elected Chair of Hydrogeology Division of GSA, 2006.
William Paul Johnson

Education
1990-1993. Ph.D. Civil Engineering University of Colorado
B.S. Geology, Whitman College.

Academic experience
2007-present. Professor, University of Utah,
2001-2007. Associate Professor, University of Utah
1995-2001. Assistant Professor, University of Utah

Non-academic experience
2012-present. Expert witness for Western Resource Advocates, Inc. regarding hydrogeochemical indicators of recharge zones and potential water quality impacts related to tar sand mining, process, and disposal adjacent to freshwater springs in Main Canyon, Tavaputs Plateau, Utah
2006-2008. Subcontractor to CH2MHill in project regarding selenium inputs, removals, and transformation in the Great Salt Lake.

Current membership in professional organizations
American Geophysical Union, American Chemical Society, Association of Environmental Engineering and Science Professors.

Honors and awards
Outstanding Faculty Research Award, Dept. Geology&Geophysics, University of Utah, 2010-11.
Outstanding Faculty Research Award, Dept. Geology&Geophysics, University of Utah, 1998-99.

Service activities
2014-2015. President Elect, Academic Senate University of Utah
2013-present. Associate Chair, Department of Geology and Geophysics, University of Utah
2012-present. Executive Committee, Academic Senate, University of Utah
Reviewer for more than 10 top-tier environmental science and engineering journals

**Important publications**


**Recent professional development activities**

Keynote Address: 1st International Conference on All Materials Fluxes in River-Ecosystem (AMFR2015), January 15-18th, 2015, Peking University, Beijing, China.

Invited Speaker:: Nanoinstitute & Pharmaceutical Chemistry Combined Seminar, University of Utah, November, 2013.


Keynote Address, International Conference on Assessing Pathogen Fate, Transport, and Risk in Natural and Engineered Water Treatment, Banff, Alberta, Canada (2012).

[http://vimeo.com/55123387](http://vimeo.com/55123387)
Jeffrey R. Moore

Education
Ph.D., Civil (Geological) Engineering, University of California, Berkeley: 2007
M.Sc., Earth Science (Geomorphology), University of California, Berkeley: 2007
M.Sc., Civil (Geotechnical) Engineering, University of California, Berkeley: 2002
B.Sc., Geological Engineering, University of Arizona: 2000

Academic experience
Assistant Professor, University of Utah, Geology & Geophysics: 2013-present, full time
Senior scientist, ETH Zurich, Engineering Geology: 2009-2012, full time
Postdoc, ETH Zurich, Engineering Geology: 2008-2009, full time
Postdoc, Lawrence Berkeley National Laboratory, Earth Science: 2007, full time

Non-academic experience
Geological Engineer (intern), Call and Nicholas, Inc., Tucson AZ: 1999-2000, part time

Current membership in professional organizations
American Geophysical Union, European Geophysical Union

Honors and awards
AGU Editor’s Citation for Excellence in Refereeing, 2007
Jane Lewis Fellowship, University of California, Berkeley, 2004 – 2006
Speaker of the Year, Association of Engineering Geologists, San Francisco Section, 2005
Outstanding Graduate Student Instructor, University of California, Berkeley, 2004

Service activities
Guest editor for Earth Surface Processes and Landforms special issue on Rock Slope Erosion and Instability Processes
Chair of annual sessions on rock fall and rock slide processes at past 5 AGU and EGU meetings
Community service: Project Youth presenter: college experience for 6th-grade students from Title-I schools; Lego League expert: grade-school student science and engineering competition
Department service: Geological engineering committee, graduate affairs committee, computer committee, undergraduate affairs committee, distinguished lecture series committee
Invited presentations: “The Bingham Canyon rock avalanche,” University of Utah, Utah Valley University, Utah State University, Association of Engineering Geologists SLC
chapter, Rio Tinto Kennecott; Bonneville exchange club, SLC; Geologists of Jackson Hole

Important publications (past 5 years)


Recent professional development activities

Instructor for Short Course on rock slope instability monitoring and characterization, ETH Zurich professional certificate of advanced studies in applied earth science.
Daniel Seely, P.E.

**Education**

2010. M.S. Civil and Environmental Engineering (Geotechnical emphasis), University of Utah.  

**Academic experience**

2014-present. Adjunct Assistant Professor, Department of Geology and Geophysics, University of Utah, Teach Geological Engineering Design course.  
2011-2014. Associate Instructor, Department of Geology and Geophysics, University of Utah, Teach courses in Geological Engineering.

**Non-academic experience**

2008-present. Director of Laboratory Services, Intermountain GeoEnvironmental Services.  
Oversee and manage operations in geotechnical laboratory, develop specialized testing equipment and procedures.  
2012-present. Senior Geotechnical Engineer, Intermountain GeoEnvironmental Services.  
Geotechnical engineering including field investigation, data interpretation, site characterization, foundation design, numerical modeling, soil and rock stability modeling, advanced geotechnical testing.  
Geotechnical engineering, field instrumentation.  
Geotechnical engineering  
Index and advanced soil mechanics testing.

**Professional registrations**

Professional Engineer, State of Utah, No. 7872141-2202.

**Current membership in professional organizations**

American Society of Civil Engineers, Member; Geo Institute, Member; American Rock Mechanics Association, Member; Earthquake Engineering Research Institute, Member.
Honors and awards

Important publications (past 5 years)


Dana J. Johnson

Education:
B.S. Mining Engineering 1984 University of Utah

Academic Experience:
Instructor University of Utah, Department of Mining Engineering (2013-present)

Non-Academic Experience:
Rocky Mountain Engineers & Land Surveyors - owner (2004-present)
Property, topographic, mineral, and construction surveys. Responsible for performing field work, and producing plats and maps, and stamping plats and maps as a professional land surveyor.


Peterson Engineering Company (2002 -2004, Spring, Summer, Fall)
Employed as a surveyor involved in property, road, and construction surveying. Experience with total station and GPS surveying equipment, and surveying techniques. Additional experience in drafting plats and documents for stamping by the professional land surveyor.

Sunrise Engineering, Inc. (1998 – 2002, Spring, Summer, Fall)
Employed as a surveyor involved in property, road, and construction surveying. Experience with total station and GPS surveying equipment, and surveying techniques.

Mining engineer responsible for evaluating mineral properties for mine development. Experience in developing mineral exploration programs, executing mineral property studies associated with economic geology, and authoring technical reports, and promoting mineral properties acquired by WEXCO to major mining companies.

Roberts and Schaefer Company (1990 – 1992)
Project engineer responsible for performing engineering feasibility studies for coal and precious metal mines. Responsible or writing mechanical and construction specifications, and evaluating vendor bids. Design engineering experience in coal, and precious metal plant design, and wastewater recovery systems.

Arentz Mining Engineers (1987 – 1990)
Chief Engineer of a gold heap-leach mining operation in Sonora Mexico. Responsible for the design and construction of mining, milling and analytical facilities. Additional responsibilities included: supervising engineers, labor, contractors, budgeting project capital, and administering project documents.
Tooele Army Depot (1985 - 1987)  
Mechanical industrial engineer responsible for writing performance, mechanical, and material handling specifications, evaluating operational studies by consulting engineers and manufactures contracting with the Department of Defense. Other Duties included: performing engineering economic studies to evaluate Army construction projects, and writing technical reports, and giving oral presentations.

Call & Nicholas 1984
Employed as a geologic technician involved in a geologic mapping project of the Bingham copper mine.

Starbridge Mining Company (Summer 1981 – 1983)  
Geologic technician involved in geochemical exploration programs in California.

Certifications or professional organizations

Certifications:
Registered Professional Land Surveyor (RPLS #169692-2201, Utah)  
Professional Ski Instructors of America (Alpine Level 3 #118565)

Professional Development Activities:
Continuing education surveying: correspondence study in public lands, construction, legal description, and land development.
MICHAEL K. McCARTER

Education:
B.S., Mining Engineering, University of Utah, Salt Lake City, Utah, June 1965;
Ph.D., Mining Engineering, University of Utah, Salt Lake City, Utah, June 1972.

Academic Positions:
University of Utah, Salt Lake City, Utah
Visiting Assistant Professor 1973 – 1976
Adjunct Associate Professor 1976 - 1978
Professor, September 1978 to present (tenured May 1981)
Associate/Acting Chair, Dept. of Mining and Fuels Engineering, May 1980 to July 1982
Chair, Mining Dept., July 1982 to July 2008
Interim Director Utah MMRRI, January 1988 to January 1989
Associate Dean, College of Mines and Earth Sciences, May 1990 to January 1992
McKinnon Endowed Chair, July 2011 to present

Industrial/Professional Positions:
Kennecott Copper Corporation, Bingham Canyon and Salt Lake City, Utah
Mine Planning Engineer, March 1975 to September 1978
Mine Project Engineer, October 1974 to February 1975
Geologist/Geotechnical Engineer, January 1970 to September 1974
Geotechnical Aide, June 1968 to September 1968 and June 1967 to September 1967
Draftsman (Western Division), June 1963 to September 1963
American Smelting and Refining Company, Salt Lake City, Utah
Geochemical Analyst, June 1964 to September 1965 and June 1966 to September 1966

Certifications/Professional Registrations
Licensed Professional Engineer, State of Utah (current)
Coal Mine Surface Blaster, State of Utah (inactive)

Current Membership – Professional Organizations
Distinguished Member of SME, Society of Mining Metallurgy and Exploration Inc.
Member of ARMA, American Rock Mechanics Association
Life Member of RMCA, Rocky Mountain Coal Mining Institute,
Member of ISEE, International Society of Explosives Engineers.
Member of UMA, Utah Mining Association
Member of MMSA, the Mining and Metallurgy Society of America
Member of SSA, Seismological Society of America

Honors and Awards
Graduated Magna Cum Laude, 1965
Outstanding Teaching Award (CMMI), 1979; (CMES), 2005
American Federation Distinguished Achievement Award in Earth Sciences, 1987
Election to the Mining and Metallurgy Society of America, 1994
Honors and Awards Continued
The Old Timers Organization Annual Faculty Award (1999)
Society for Mining, Metallurgy, and Exploration, Distinguished Member Award, 2003
Rocky Mountain Coal Mining Institute, Honorary Member - service in education, 2004
Utah Mining Association, Distinguished Service Award, 2008
Team of Excellence Award for Mining Engineering (Mining Department), 2009
McKinnon Endowed Chair, 2011

Current Service
Counselor, MMSA Utah Section, 1998 - present
Rio Tinto, Bingham Canyon Mine, Mine Technical Review Team, Manefay Slide recovery
and other geotechnical/mine planning issues, 2011 to present
Research proposal reviewer for U of U Seed Grant Program, 2008 to present
Organizing Committee, (International Conf. for Ground Control in Mining 2012 – present
Technical paper reviewer for ARMA 2013 - present
Technical paper reviewer for ICGMC 2012 - present
Technical paper reviewer for International Fragblast 2015 - present
Research proposal reviewer for ICCI (Illinois Clean Coal Institute) 2011 to present
Voting member, Technical Advisory Committee, Utah Labor Commission – Office of Coal
Mine Safety, 2009 – present

Selected Publications
of Seismic Events Related to the Crandall Canyon Collapse, (32nd ICGMC) (Best of conf.)
Seismicity at the Trail Mountain Mine using modified hypocentral relocation techniques.
Bulletin Seismological Society of America
Wempen, J., M. K. McCarter. 2014, Time Dependent Mining-Induced Subsidence Measured by
Differential Interferometric Synthetic Aperture Radar. (33rd ICGMC) (Best of conf.)
seismicity before and after the 2007 Crandall Canyon Mine collapse. Journal of
Geophysical Research: Solid Earth.
Correlation of Newly Detected Mining Induced Seismicity with Subsidence in a Wyoming
Mining District. SME Annual Meeting,. Denver, Colorado, presentation and pre-print.
Computational Challenge, accepted for presentation and inclusion in proceedings, APCOM,
Fairbanks, Alaska.

Professional Development
Regular attendance at technical sessions of local and annual SME meetings, annual ICGMC,
annual RMCMI, occasional ARMA, and review monthly Mining Engineering. Active
consulting. Maintain mandatory minimum of 15 hours/year of continuing education for PE
license.
Faculty Resume

1. NAME
   Steven F. Bartlett
   Ph.D., P.E.

2. EDUCATION
   Degree Institution Field Date
   Ph.D. Brigham Young University Civil Engineering 1992
   B.S. Brigham Young University Geology 1983

3. YEARS of ACADEMIC SERVICE
   Dates Rank (FTE) Institution
   2007 – present Associate Professor – full time University of Utah
   2000 – 2007 Assistant Professor – full time University of Utah

4. OTHER RELATED EXPERIENCE
   Research Project Manager, Utah Department of Transportation, 1998 – 2000
   Woodward-Clyde Consultants, Salt Lake City, Utah, 1996 – 1998

5. REGISTRATION (in past 5 years)
   Registered Professional Engineer, Utah, No. 176935-2202.

6. MEMBERSHIPS (in past 5 years)
   American Society of Civil Engineers
   Earthquake Engineering Research Institute

7. HONORS AND AWARDS (in past 5 years)
   American Council of Engineering Companies, Utah, Engineering Excellence Grand Award, 2011
   American Public Works Association, National Project of the Year, 2010, ASCE 2010 Local Outstanding Civil
   Engineering Achievement Awards - Geotechnical Category – Outstanding Award SR 519 / I-90 to
   Dean’s Recognition, placed among top instructors, College of Engineering, 2010, 2007
   ACEC Arizona Grand Award, Rockfall Containment and Safety, SR 264 at 2nd Mesa, 2006
   ASCE Outstanding Civil Engineering Achievement (OPAL) Award, 2002 Wasatch Constructors I-15

8. PROFESSIONAL SERVICE (in past 5 years)
   Organizing Committee EPS 2017, Istanbul Turkey, 2014-2017
   Member, Next Generation Liquefaction Triggering Database, PEER, 2014
   Participating Member, National Research Council of the National Academies, Liquefaction, 2014.
   Director, Earthquake Engineering Research Institute, Utah Chapter, 2012-2013.
   Committee on Pre and Post-Disaster Mitigation, ASCE Council on Disaster Reduction and Management, 2009 to
   2011 (chair).
   Led ASCE CDRM Reconnaissance Team Investigation of L’Aquila, Italy Earthquake, 2009.
   Earthquake Engineering Research Institute/Western States Seismic Policy Committee Annual Meeting Planning
   Committee, 2009 (member).
   Advanced National Seismic System, Intermountain West Regional Advisory Council (alternate)
   Steering Committee, EPS 2011 (member).

9. PUBLICATIONS/ENGINEERING REPORTS (representative sample selected in past 5 years)
   Performance Monitoring of MSE Walls Constructed With and Without Soil Improvement,” Conference
   Proceedings of Transportation Research Board Annual Meetings, January 11th to 15th, 2015,


10. PROFESSIONAL DEVELOPMENT (Sample Selected from the Last Five Years)

- Speaker at EPS 2011 in Oslo, Norway.
- Sabbatical Fall Semester 2013 with Norwegian Public Roads Administration, Oslo Norway.
- Keynote address, Conference on Geosynthetic Uses and Applications, Bogazici University, Istanbul Turkey, May 29th, 2014.
- Participation in the NRC liquefaction workshop, Tempe, Arizona, 2014.
- Keynote Address, 1st Geofoam Conference in Latin America, Mexico City, Mexico, February, 24th 2015.
Faculty Resume

1. NAME
Evert C. Lawton
Ph.D., P.E., Professor

2. EDUCATION

<table>
<thead>
<tr>
<th>Degree</th>
<th>Institution</th>
<th>Field</th>
<th>Date</th>
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<tr>
<td>Ph.D.</td>
<td>Washington State University</td>
<td>Civil Engineering: Geotechnical</td>
<td>1986</td>
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<tr>
<td>M.S.</td>
<td>San Diego State University</td>
<td>Civil Engineering: Geotechnical</td>
<td>1983</td>
</tr>
<tr>
<td>M.E.</td>
<td>University of Virginia</td>
<td>Civil Engineering: Structural</td>
<td>1980</td>
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<tr>
<td>B.S.</td>
<td>University of Virginia</td>
<td>Civil Engineering: Structural</td>
<td>1977</td>
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3. YEARS of ACADEMIC SERVICE

<table>
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<tr>
<th>Dates</th>
<th>Rank (FTE)</th>
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<tbody>
<tr>
<td>2002–present</td>
<td>Professor</td>
<td>University of Utah</td>
</tr>
<tr>
<td>2012–present</td>
<td>Associate Chair</td>
<td>University of Utah</td>
</tr>
<tr>
<td>1994-2002</td>
<td>Associate Chair</td>
<td>University of Utah</td>
</tr>
<tr>
<td>1994-2002</td>
<td>Associate Professor</td>
<td>University of Utah</td>
</tr>
<tr>
<td>1991-1994</td>
<td>Assistant Professor</td>
<td>University of Utah</td>
</tr>
<tr>
<td>1987-1991</td>
<td>Assistant Professor</td>
<td>University of Miami</td>
</tr>
<tr>
<td>1984-1986</td>
<td>Teaching &amp; Research Assistant</td>
<td>Washington State University</td>
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4. OTHER RELATED EXPERIENCE
Construction Manager, Schnabel Foundation Co., Dallas, Texas, Summer 1985
Geotechnical Engineer Bridge Division, Virginia Department of Highways and Transportation, Richmond, Virginia, 1982 – 1984
Structural Engineer, Bridge Division, Virginia Department of Highways and Transportation, Richmond, Virginia, 1977 – 1981

5. REGISTRATION (in past 5 years)
California Professional Engineer License No. C039328
Florida Professional Engineer License No. 37850 (currently inactive)
Utah Professional Structural Engineer License No. 190745-2203
Virginia Professional Engineer License No. 13774 (currently inactive)
Washington Professional Engineer License No. 22069

6. MEMBERSHIPS (in past 5 years)
American Society of Civil Engineers, Member
International Society for Soil Mechanics and Geotechnical Engineering, Member

7. HONORS AND AWARDS (in past 5 years)
University Distinguished Teaching Award, University of Utah, 2012

8. PROFESSIONAL SERVICE (in past 5 years)

9. PUBLICATIONS/ENGINEERING REPORTS (representative sample selected in past 5 years)


10. PROFESSIONAL DEVELOPMENT (Sample Selected from the Last Five Years)
## Appendix C – Equipment

### Table C.1 Geological Engineering Laboratories

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<tr>
<th>Class #</th>
<th>Class Title</th>
<th>Room # and Bldg. where labs are taught</th>
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<tbody>
<tr>
<td>GG 3010</td>
<td>Geophysics</td>
<td>250 FASB</td>
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<tr>
<td>GG 3060</td>
<td>Structural Geology</td>
<td>295 FASB</td>
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<tr>
<td>Geo 3080</td>
<td>Earth Materials I</td>
<td>375 FASB</td>
</tr>
<tr>
<td>Geo 3090</td>
<td>Earth Material II</td>
<td>375 FASB</td>
</tr>
<tr>
<td>Geo 5150</td>
<td>Geological Engineering Design</td>
<td>489 FASB &amp; 206 FASB</td>
</tr>
<tr>
<td>Geo 5350</td>
<td>Groundwater</td>
<td>250 FASB &amp; 206 FASB</td>
</tr>
<tr>
<td>Geo 5360</td>
<td>Fluid Dynamics of Earth Materials</td>
<td>483 FASB &amp; 206 FASB</td>
</tr>
<tr>
<td>Geo 5385</td>
<td>Introduction to Groundwater Modeling</td>
<td>206 FASB</td>
</tr>
<tr>
<td>Geo 5390</td>
<td>Solute Transport and Subsurface Remediation</td>
<td>206 FASB</td>
</tr>
<tr>
<td>Geo 5560</td>
<td>Numerical Methods in Geosciences</td>
<td>206 FASB</td>
</tr>
</tbody>
</table>

### Table C.2 Computer Teaching Facilities

<table>
<thead>
<tr>
<th>Name</th>
<th>Location</th>
<th># Computers</th>
<th>Type</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geology &amp; Geophysics</td>
<td>205 FASB</td>
<td>18</td>
<td>Ceiling mounted digital projector</td>
<td>Sutton Building</td>
</tr>
<tr>
<td>GG Mobile Lab</td>
<td>375 FASB</td>
<td>17</td>
<td>Sutton Building</td>
<td></td>
</tr>
<tr>
<td>Geological Engineering</td>
<td>205 FASB</td>
<td>18</td>
<td>Ceiling mounted digital projector</td>
<td>Geostudio software</td>
</tr>
</tbody>
</table>
Table C.3 Equipment lists and estimated replacement year for courses in the Geological Engineering program.

### Equipment List for GEO 3010

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Estimated Replacement year (e.g. 2020)</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lacoste-Romberg Gravimeter</td>
<td>2</td>
<td>&gt;2016</td>
<td></td>
</tr>
<tr>
<td>Proton Recession Magnetometer</td>
<td>2</td>
<td>&gt;2016</td>
<td></td>
</tr>
<tr>
<td>Bison 24-Channel Seismic System</td>
<td>1</td>
<td>&gt;2016</td>
<td></td>
</tr>
<tr>
<td>Altimeters</td>
<td>4</td>
<td>&gt;2016</td>
<td></td>
</tr>
<tr>
<td>Portable GPS</td>
<td>9</td>
<td>&gt;2016</td>
<td></td>
</tr>
<tr>
<td>IMac computers</td>
<td>17</td>
<td>2016</td>
<td>375 FASB</td>
</tr>
<tr>
<td>P.C. Computers</td>
<td>18</td>
<td>2016</td>
<td>206 FASB</td>
</tr>
</tbody>
</table>

### Equipment List for GEO 3060

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Estimated Replacement year (e.g. 2020)</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brunton compasses</td>
<td></td>
<td></td>
<td>See GEO 4500, 4510</td>
</tr>
<tr>
<td>Computer Lab</td>
<td>18</td>
<td>2016</td>
<td></td>
</tr>
</tbody>
</table>

### Equipment List for GEO 3080/3090

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Estimated Replacement year (e.g. 2020)</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Mineral and rock specimens</td>
<td>~50 sets</td>
<td>As needed, based on yearly inventory</td>
<td>Continuous replacement</td>
</tr>
<tr>
<td>Item Description</td>
<td>Quantity</td>
<td>Maintenance</td>
<td>Replacement</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------------</td>
<td>----------</td>
<td>-------------</td>
<td>-------------</td>
</tr>
<tr>
<td>*Mineral testing materials (acid, streak plates, magnets, etc.)</td>
<td>20 sets</td>
<td>As needed, based on yearly inventory</td>
<td>Reconditioned yearly</td>
</tr>
<tr>
<td>*Pocket lasers and batteries</td>
<td>10 sets</td>
<td>As needed, based on yearly inventory</td>
<td>Continuous replacement</td>
</tr>
<tr>
<td>*Diffraction slides</td>
<td>10 sets</td>
<td>As needed, based on yearly inventory</td>
<td>Continuous replacement</td>
</tr>
<tr>
<td>*Custom mineral kit</td>
<td>8 sets</td>
<td>As needed, based on yearly inventory</td>
<td>Reconditioned yearly</td>
</tr>
<tr>
<td>Crystal Models (wood, plastic)</td>
<td>1 set</td>
<td>None</td>
<td>Estimated life &gt;50 yrs.</td>
</tr>
<tr>
<td>*Mortar and Pestles,</td>
<td>12 sets</td>
<td>As needed, based on yearly inventory</td>
<td>Continuous replacement</td>
</tr>
<tr>
<td>*Hardness testers</td>
<td>2 sets</td>
<td>As needed, based on yearly inventory</td>
<td>Reconditioned yearly</td>
</tr>
<tr>
<td>Handlens (10X)</td>
<td>1 per student</td>
<td>Student supplied</td>
<td></td>
</tr>
<tr>
<td>*Chemicals (NaCl, KCl, MgCl₂, CaCl₂, HCl, sand)</td>
<td>10 gm, 20 ml</td>
<td>As needed, based on yearly inventory</td>
<td>Continuous replacement</td>
</tr>
<tr>
<td>*Geologic maps</td>
<td>4 sets</td>
<td>As needed, based on yearly inventory</td>
<td>Continuous replacement</td>
</tr>
<tr>
<td>*Glassware (beakers, tubes, funnels, stirring rods, etc)</td>
<td>8 sets</td>
<td>As needed, based on yearly inventory</td>
<td>Continuous replacement</td>
</tr>
<tr>
<td>Hot plates</td>
<td>4</td>
<td>None</td>
<td>Estimated life &gt;50 yrs.</td>
</tr>
<tr>
<td>Jolly Balance</td>
<td>1</td>
<td>None</td>
<td>Reconditioned yearly Estimated life &gt;50 yrs.</td>
</tr>
<tr>
<td>Leitz binocular microscopes</td>
<td>4</td>
<td>None</td>
<td>Estimated life &gt;50 yrs.</td>
</tr>
<tr>
<td>Equipment</td>
<td>Quantity</td>
<td>Condition</td>
<td>Location</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>----------</td>
<td>-----------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td>X-ray powder diffractometer</td>
<td>1</td>
<td>None</td>
<td>Department Research Facility</td>
</tr>
<tr>
<td>Electron Microprobe</td>
<td>1</td>
<td>None</td>
<td>Department Research Facility</td>
</tr>
<tr>
<td>*Field Vehicles (12 passenger)</td>
<td>3</td>
<td>None</td>
<td>University Rental</td>
</tr>
<tr>
<td>Computer projector</td>
<td>1</td>
<td>None</td>
<td>Department A/V</td>
</tr>
<tr>
<td>iMac mobile computer lab with imation and zip drives / network printer</td>
<td>17 units</td>
<td>~2010</td>
<td>Department Lab</td>
</tr>
<tr>
<td>Computer programs (MS Word, Excel, Powerpoint, SHAPE, Crystal maker, etc.)</td>
<td>17 licenses</td>
<td>None</td>
<td>Department licenses</td>
</tr>
<tr>
<td>Qemscan</td>
<td>1</td>
<td>None</td>
<td>Department Research Facility</td>
</tr>
<tr>
<td>Reflected/transmitted light petrographic microscope</td>
<td>1</td>
<td>None</td>
<td>Estimated life &gt;50 yrs.</td>
</tr>
<tr>
<td>TV camera and Monitor</td>
<td>1</td>
<td>None</td>
<td>Estimated life &gt;10 yrs.</td>
</tr>
<tr>
<td>Platinum crucible</td>
<td>1</td>
<td>ASAP</td>
<td>Indefinite, but existing item is badly worn</td>
</tr>
<tr>
<td>Ceramic crucibles</td>
<td>12</td>
<td>As needed, based on yearly inventory</td>
<td>Continuous replacement</td>
</tr>
<tr>
<td>Muffle furnaces</td>
<td>2</td>
<td>None</td>
<td>Estimated life &gt;20 years</td>
</tr>
</tbody>
</table>

*Maintained by course fees
### Equipment List for GEO 4500/4510

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Estimated Replacement year (e.g. 2020)</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brunton compasses (pocket transits)</td>
<td>45</td>
<td>Replace over 30 years</td>
<td></td>
</tr>
<tr>
<td>GPS devices</td>
<td>10</td>
<td>Replace over 24 years</td>
<td>This estimate is based on attrition. Unlike Bruntons, GPS devices are likely to be obsolete long before they are lost to attrition.</td>
</tr>
<tr>
<td>Acid bottles</td>
<td>45</td>
<td>Replaced each year</td>
<td></td>
</tr>
<tr>
<td>Dept. Vehicles</td>
<td>6</td>
<td>Replace over 20 years</td>
<td></td>
</tr>
</tbody>
</table>

### Equipment List for GEO 5150

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Estimated Replacement year (e.g. 2020)</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>P.C. Computer lab</td>
<td>18</td>
<td>2010</td>
<td></td>
</tr>
</tbody>
</table>

### Equipment List for GEO 5350

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Estimated Replacement year (e.g. 2020)</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water level probes</td>
<td>3</td>
<td>Replace over 20 years</td>
<td>For large classes (e.g. 40 in 2001) a second tank would be useful.</td>
</tr>
<tr>
<td>Sand tank</td>
<td>1</td>
<td>2016</td>
<td></td>
</tr>
<tr>
<td>Description</td>
<td>Quantity</td>
<td>Estimated Replacement year (e.g. 2020)</td>
<td>Comment</td>
</tr>
<tr>
<td>--------------------------------------------</td>
<td>----------</td>
<td>----------------------------------------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Slugs, for single well tests</td>
<td>2</td>
<td>&gt;2050</td>
<td></td>
</tr>
<tr>
<td>Portable pump for aquifer testing</td>
<td>1</td>
<td>2016</td>
<td></td>
</tr>
<tr>
<td>Portable generator to power pump</td>
<td>1</td>
<td>2016</td>
<td></td>
</tr>
<tr>
<td>Air permeameters</td>
<td>6</td>
<td>&gt;2050</td>
<td></td>
</tr>
<tr>
<td>GMS groundwater modeling software</td>
<td></td>
<td></td>
<td>Renewed annually</td>
</tr>
<tr>
<td>Wells</td>
<td>13</td>
<td>Add 1 per year</td>
<td>We plan to expand the well field in Red Butte canyon by 1 well per year</td>
</tr>
</tbody>
</table>

### Equipment List for GEO 5360

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Estimated Replacement year (e.g. 2020)</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Custom-manufactured plexiglass wave tanks (3 m x 30 cm x 10 cm)</td>
<td>3</td>
<td>&gt;2016</td>
<td></td>
</tr>
<tr>
<td>Custom-manufactured plexiglass flumes (approximately 1 m in length)</td>
<td>4</td>
<td>&gt;2016</td>
<td></td>
</tr>
<tr>
<td>25-watt pumps</td>
<td>3</td>
<td>&gt;2050</td>
<td></td>
</tr>
</tbody>
</table>

### Equipment List for GEO 5385

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Estimated Replacement year (e.g. 2020)</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computers in Lab</td>
<td>18</td>
<td>2007</td>
<td></td>
</tr>
<tr>
<td>GMS software</td>
<td>1 site license</td>
<td>2009</td>
<td>Renewed annually</td>
</tr>
</tbody>
</table>
### Equipment List for GEO 5390

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Estimated Replacement year (e.g. 2020)</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dept. Vehicles</td>
<td>6</td>
<td>Replace over 20 years</td>
<td></td>
</tr>
<tr>
<td>Computers in Lab</td>
<td>18</td>
<td>2016</td>
<td></td>
</tr>
<tr>
<td>GMS software</td>
<td>1 site license</td>
<td></td>
<td>Renewed annually</td>
</tr>
</tbody>
</table>

### Equipment List for GEO 5760

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Estimated Replacement year (e.g. 2020)</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rock samples</td>
<td>200</td>
<td>?</td>
<td>All sed types</td>
</tr>
<tr>
<td>Jacob’s Staffs</td>
<td>12</td>
<td>2003</td>
<td></td>
</tr>
<tr>
<td>Computer lab</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dept. vehicles</td>
<td>6</td>
<td>Replace over 20 years</td>
<td></td>
</tr>
</tbody>
</table>
Appendix D – Institutional Summary

1. **The Institution**
   a. **Name and address of the institution**
      
      University of Utah  
      201 Presidents Circle, Room 201  
      Salt Lake City, UT 84112

   b. **Name and title of the chief executive officer of the institution**
      
      Dr. David Pershing, President  
      Office of the President  
      Park Building  
      201 S. President’s Circle, Room 203  
      Salt Lake City, UT 84112

      Dr. Ruth Watkins, Sr. Vice President  
      Academic Affairs  
      Park Building  
      201 S. President’s Circle, Room 205  
      Salt Lake City, UT 84112

   c. **Name and title of the person submitting the Self-Study Report.**
      
      Dr. Francis H. Brown, Dean  
      College of Mines and Earth Sciences

   d. **Name the organizations by which the institution is now accredited, and the dates of the initial and most recent accreditation evaluations.**

      The University of Utah is accredited by Northwest Association of Schools and Colleges; the initial accreditation was April 6, 1932.

      The most recent accreditation of the University of Utah, and all of its component schools, colleges and departments was completed in October 1, 2012, by the Northwest Commission on Colleges and Universities
2. **Type of Control**

The University of Utah is a state institution under the jurisdiction of the Utah State Board of Regents, whose members are appointed by the Governor of the State of Utah and confirmed by the Legislature. The Regents appoint a Commissioner of Higher Education who, with his staff, has the responsibility of coordinating policy, programs and budgets for higher education statewide. The President of the university reports to the Board of Trustees, which reviews and approves the policies, programs, budgets and personnel actions of the University.

3. **Educational Unit**

The University as a whole is administered by two Senior Vice Presidents — an Academic Vice President, and a Vice President of Health Sciences. Engineering subjects are taught in two colleges at the University of Utah: the College of Mines and Earth Sciences, and the College of Engineering. Geological Engineering is a program in the College of Mines and Earth Sciences. Students in Geological Engineering take some of their coursework from departments in the College of Engineering to avoid duplication of courses within the institution. The organizational chart provided below includes the two relevant colleges, with each program name and its administrators in bold face.

**Organizational Structure**
College of Mines and Earth Sciences (Francis H. Brown Dean)

The College of Mines and Earth Sciences is composed of four departments: Geology & Geophysics, Mining Engineering, Atmospheric Sciences, and Metallurgical Engineering. In addition it houses the University of Utah Seismograph Stations.

Its mission is (i) to educate and prepare professional earth scientists, geological engineers and earth science educators, meteorologists, and atmospheric scientists, physical and extractive metallurgists, mineral separation experts, and mining engineers; (ii) to engage in scholarly research activities in geology, geophysics, geological engineering, meteorology, physical and extractive metallurgy, mineral separation and mining engineering; (iii) to disseminate newly acquired knowledge through timely publication of original research by faculty and students in all of the above fields. To educate the University community and the public about the composition and structure of Earth, processes that shape it, and its history and future and; to provide professional service by providing knowledge about natural resources, methods of natural resource extraction, safety in industrial activities, metals extraction and modification, geologic hazards, the environment, and a sustainable earth.

Three departments offer engineering subjects: Geology & Geophysics, Metallurgical Engineering, and Mining Engineering. The Chairs of these departments are:

- Dr. John Bartley, Department of Geology & Geophysics
- Dr. Mano Misra, Department of Metallurgical Engineering
- Dr. Michael G. Nelson, Department of Mining Engineering

The College of Mines and Earth Sciences offers the only undergraduate and graduate programs in Metallurgical Engineering, Mining Engineering, and Geological Engineering in Utah. There are no restrictions to access or to enrollment in any of these programs save admissions requirements to the Graduate School. In Fall 2014 there were 372 undergraduate students in the College distributed as follows: Geology & Geophysics (160); Metallurgical Engineering (65); Atmospheric Sciences (76); Mining Engineering (95).

Nearly all of our courses are taught on-campus during Fall and Spring Semesters. Most undergraduate courses have a traditional lecture format; many professional courses include a laboratory section and/or field trips. Many graduate courses are taught as seminars, but many also have laboratory sections and field trips. An earthquake education coordinator in the Seismograph Stations develops programs about earthquake awareness and safety with the public school system and other organizations.

WEST (Water, the Environment, Science & Teaching) is a science education outreach program in the College of Mines & Earth Sciences. WEST provides fellowships to graduate students in geology, geophysics, atmospheric sciences, and biology to work with a K-12 school for an entire academic year. WEST fellows help teachers with content knowledge, design inquiry-based activities, and provide authentic science experiences for students. Teachers, in turn, help fellows develop teaching, communication, and time management skills that will be critical to success in their post-graduate careers. WEST fellows also meet each week in an interdisciplinary seminar to share their research and teaching experiences. WEST has been in operation for 12 years and
has funded 57 fellows. WEST is funded through contributions from various University entities, the Salt Lake City School District, and private donors.

EAST (Embedded Alliance for Science Teaching) is a companion program to WEST that provides fellowships for undergraduate students to develop science alliances with teachers, schools, and the Utah Museum of Natural History. EAST fellows design their own teaching projects and may work one-on-one with students, run field trips, serve as science fair mentors, teach K-12 classes, or help with teacher professional development activities. EAST has been in operation for three years and has funded 24 fellows. EAST is funded through a Math and Science Partnership grant from the National Science Foundation.

Undergraduate student progress is monitored by committee, or by individual undergraduate advisors; progress in graduate programs, by the supervisory committee of each student. A staff member in each department maintains records of current students. Chairs certify that their students have completed graduation requirements. Graduating students are invited to a confidential exit interview with their departmental Chair.

Some lower division courses require memorization and vocabulary, but homework problems and laboratory assignments achieve the problem-solving objective in such courses. In upper division and graduate level courses, critical thinking ability and problem-solving skills are emphasized, as is analytical judgment and scientific reasoning. Homework assignments, laboratory exercises, field trip reports, and term papers require students to make independent interpretations and arguments. Most courses have mid-term and/or final examinations that typically employ numerical problems and essay questions. Since many courses concern utilization of natural resources and understanding of environmental effects, consideration of societal values is included. Engineering course work emphasizes the importance of individual responsibility in making recommendations and acting on those recommendations.

Nearly all courses emphasize written and/or oral communication - written homework assignments and/or term papers are required. Essay exams are the norm for most professional courses. Student achievement is recorded using the A through E grading system. The national Fundamentals of Engineering Exam is required for graduation in Mining Engineering and in Geological Engineering.

The objectives of our undergraduate programs are being achieved under the present organization, and our facilities and resources are adequate to support those programs.

The college has 51 regular faculty members distributed as follows: Geology & Geophysics (25), Metallurgical Engineering (10), Atmospheric Sciences (11), Mining Engineering (5). Eight are female, the rest male. Most are from English Speaking cultures, but Chinese, Japanese, German, Baltic, Tungusic/Korean, Western Slavic, Russian, Iberian, Dravidian, and Central Indic cultures are represented by one or more individuals. All faculty have doctorates in their fields of expertise. One faculty member (Dean of the College of Mines and Earth Sciences) works as administrator, but continue to teach and conduct research. They are included in the totals above. Auxiliary faculty include xx research faculty and xx adjunct faculty. Regular faculty with adjunct appointments in another department are excluded from this count. Most have doctoral degrees in their fields of expertise.

Since 2009 faculty have published hundreds of technical papers, presented hundreds of papers at national and international scientific meetings, and been awarded average funding of ~$12 M per
year. In the past five years, virtually all faculty have collaborated with researchers at other institutions; more than half have done research in foreign countries. All belong to at least one national and/or international professional society.

Of the 51 tenure-track faculty members, one is a member of the National Academy of Science, one is a member of the National Academy of Inventors and 1 is a member of the National Academy of Engineering. Most faculty members routinely involve students in their research activities, regularly publish their work in refereed national journals, and have international scientific reputations. The faculty have generated external funding for research projects at an average rate of over $230,000/year/faculty member in the last five years. Many have served as members of National Science Foundation review panels. Many have conducted scientific research in foreign countries. Many have presented their research results at scientific meetings outside the U.S. Over half have served as officers or committee chairs of national/international societies. Over half are or have been editors or associate editors of international scientific journals. Many are Fellows of major scientific organizations (e.g., Amer. Association for the Advancement of Science, American Geophysical Union, Geological Society of America, Society of Economic Geologists, Metallurgical Society, ASM International, Society of Mining Engineers AIME, International Society for Rock Mechanics, International Society of Explosives Engineers, Mining & Metallurgy Society of America, American Society of Civil Engineers, Water Environment Federation, International Ground Water Assoc., etc.).

The University recognizes the "mutual relevance and interdependence of teaching and research as essential components of academic excellence." xx of our faculty have received the University's Distinguished Faculty Research Award, five of our faculty have received the University's Distinguished Faculty Research Award, six have been Faculty Research Fellows, three have been named Presidential Teaching Scholars, two have received the Hatch Prize, and three have received the Rosenblatt prize for excellence in teaching, research, and administration. About two-thirds of the faculty members who have been selected as outstanding teachers have also been noted as outstanding researchers.

Departmental chairs allocate departmental resources in consultation with their faculties. The Dean allocates resources within the College in consultation with the College Executive Committee. Undergraduate instruction is generally given higher priority than graduate instruction in allocation. These practices appear to be appropriate.

Money for academic endeavors from external sources exceeds the amount from the state several fold. Without these monies generated by researchers, our academic and educational activities would be curtailed severely.

Our faculty salaries are, on average, somewhat below those of comparable faculties nationally. Average salary for a full professor in the College is 82.6% of that in science colleges nationally. Hence, we are competitively disadvantaged in hiring at above entry level. We do remain competitive for entry level hires, but salary compression results in advanced ranks being undercompensated on a national basis.

Twenty-two professors, eight associate professors, and one assistant professor (69% of the regular faculty), are supported at <1.00 FTE from state funds. Two full professors derive part of their salary from endowed chairs; salaries of the remaining fifteen professors, the associate professors, and the assistant professors are supplemented by other endowed funds, or by research funds.
State appropriations for clerical and professional staff, operations, capital equipment, and travel are underfunded throughout the college, though progress has been made since the last review. Some clerical and professional staff are supported by soft monies and salaries of others are supplemented from endowed funds. Supplies and expenses budgets have not increased in twenty-one years, which is a growing difficulty across campus. Capital equipment in the College is acquired primarily from external gifts and grants, but some instructional equipment is provided through state funds. In 2015, Metallurgical engineering received $60,000 from Engineering Initiative ($40,000 from the state with additional $20,000 match from the College) to upgrade and/or repair instrumentation in several of the instructional laboratories in Metallurgical Engineering. These funds were utilized to service the XRD; acquire new furnaces for the heat treatment; service microscope and acquire computer and digital microscopy cameras for the microscopy laboratory; acquire instructional kits for fluid flow lab; and repair equipment in Mineral Processing Laboratories. Surveying equipment and computer facilities in Mining Engineering were upgraded in 2015 by funds from the central administration, as have departmental computers capable of running AutoCAD. The principal computing laboratory for undergraduate Mining Engineers has been moved to the third floor of the Browning Building, bringing it into the heart of the department. At some level all engineering programs receive college funds to support undergraduate instruction.

Our physical facilities for teaching have markedly increased in quality and suitability for instruction over the past decade. A new laboratory building for Metallurgical Engineering, the Ivor Thomas Laboratory, opened in December, 2007; a new building for Geology & Geophysics, the Frederick Albert Sutton Building, opened in December 2008. Major renovations have been made to Building 58, in order to provide space for research, and many renovations are being made to the Browning Building (which houses Atmospheric Sciences, Metallurgical Engineering, and Mining). The majority of the funds for these new structures and newly modified space have come from alumni and friends. Further improvements are under way. In addition to the Sutton building lecture hall, we continue to use classrooms in the John and Marva Warnock Building (formerly the Energy and Minerals Classroom Building) for large non-majors classes, and these spaces are excellent. Teaching space in the William Browning Building has been improved through installation of digital projectors in all the class rooms and upgrades of furniture.

Our research equipment is up-to-date, nearly all is purchased with funds generated from external sources. Analytical capabilities of interest to geological engineering include: scanning electron microscopy, x-ray diffraction, mass spectrometry, downhole logging instruments, short wavelength radar, shallow-seismic equipment, and facilities for measuring mechanical and engineering properties of rock. Several new laboratories and research programs that enhance student experience have been established in Metallurgical Engineering through research grants and private gifts. These include (i) Renewable Energy laboratory, (ii) Nuclear Pyro-Metallurgy Laboratory, (iii) Center for Hydrogen Storage Materials Development, (iv) Powder Metallurgy Processing and Characterization Facility, (v) Electric Field Activated Sintering Laboratory and (vi) Metal Recycling Laboratory. Major new equipment acquisitions include (i) Hitachi High Resolution SEM, (ii) Rigaku X-ray Diffractometer, (iii) Micro X-ray Tomography System, (iv) JPK Nanowizard 3a Ultra AFM and (v) GT Advanced Technologies 10-ton 4000A SPS unit. In addition, JEOL 28000 High Resolution Microscope with fast EDS (university-wide facility) has been acquired by the University under NSF MRSEC grant through matching funds from the.
This facility along with other major instrumentation is located in the Micron Imaging Facilities located in the USTAR building.

Mining Engineering has a machine shop (with machinist), and a lab for coring and shaping rock specimens. Geology & Geophysics has extensive teaching and research collections of rocks, minerals and fossils, and a petrographic technician who also serves as curator of the collections.

Our computing facilities are excellent, and are supported by two full-time computer systems analysts responsible for networking and all machines, who also install and maintain PCs and MACs as needed. Atmospheric Sciences, Geology & Geophysics, and the Seismograph Stations employ computer systems analysts to assist with research and instruction. The College of Mines & Earth Sciences's teaching computer facilities include four fixed desktop classrooms located in FASB 206, FASB 234, WBB 212 and WBB 306; and a mobile group of 28 laptops stored in FASB 104 having a combined total of 81 computers. The FASB 206 and 212 classrooms consist of Apple iMac computers, each equipped with 16 GB RAM and a 27-inch screen, providing a base host OSX and virtual machines for Linux and Windows applications for both department specific and general needs. FASB 206, FASB 212, and the mobile systems provide the most comprehensive systems for classroom use. The WBB 306 and FASB 234 classrooms consist of generic X86-64 architecture computers only providing Windows for specific department applications. We are currently in the process of expanding the FASB 234 classroom to accommodate more students. Included in the many installed cost free and commercial programs with cost are the following:

A. Specialized Technical Software:

<table>
<thead>
<tr>
<th>Software</th>
<th>Software</th>
<th>Software</th>
<th>Software</th>
</tr>
</thead>
<tbody>
<tr>
<td>3dem</td>
<td>Geochemist's</td>
<td>Microdem</td>
<td>Associates</td>
</tr>
<tr>
<td>Aqtesolv</td>
<td>Workbench</td>
<td>Mineplan</td>
<td>StereoWin</td>
</tr>
<tr>
<td>ArcGIS</td>
<td>Global</td>
<td>Petra Petrel</td>
<td>Survcadd</td>
</tr>
<tr>
<td>Autocad</td>
<td>Mapper</td>
<td>PetroMod</td>
<td>Vista Sesimic</td>
</tr>
<tr>
<td>GM-SYS</td>
<td>Kingdom</td>
<td>Phreeqc</td>
<td>Processing</td>
</tr>
<tr>
<td>GMS</td>
<td>Suite</td>
<td>Interactive</td>
<td>VnetPC</td>
</tr>
<tr>
<td>Geo-</td>
<td>Loadest</td>
<td>Plate River</td>
<td>Vulcan</td>
</tr>
<tr>
<td>Slope</td>
<td>MatLab</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

B. General Software:

<table>
<thead>
<tr>
<th>Software</th>
<th>Software</th>
</tr>
</thead>
<tbody>
<tr>
<td>VirtualBox</td>
<td>Parallels</td>
</tr>
<tr>
<td>Gimp</td>
<td>Google Earth</td>
</tr>
<tr>
<td>Microsoft Office</td>
<td></td>
</tr>
</tbody>
</table>

C. Software installed during the next classroom updates:

<table>
<thead>
<tr>
<th>Software</th>
<th>Software</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adobe Illustrator</td>
<td>Linux programs</td>
</tr>
</tbody>
</table>

In addition, Marriott Library has student computer and support facilities as described under the Libraries section. For high end, intensive computing, service is provided by the Center for High
Performance Computing located in the Intermountain Networking and Scientific Computing Center (INSCC) adjacent to the principal buildings of the college; fiber optic connections to that organization exist in both the Sutton and Browning Buildings.

Each department in the College is evaluated every seven years by the Graduate Council. Graduate Council reviews for Mining Engineering and Metallurgical Engineering took place during in 2009-2010. Atmospheric Sciences; and Geology & Geophysics were last reviewed in 2010-2011.

Tenure-track faculty are reviewed annually for merit salary increases. Criteria considered include: teaching effectiveness, scholarly productivity, service, and professional reputation. The reviewing body evaluates each faculty member and provides a confidential ranking for consideration in awarding merit increases. Anonymous student course evaluations provide quantitative and qualitative measures of teaching performance that weigh seriously in retention, tenure, promotion and merit review deliberations. Special recognition for outstanding teaching is considered in reviewing teaching performance, as is initiation of new courses or substantial revision of existing courses. Further, the College makes one award at commencement each year to a faculty member who has performed exceptionally well in instruction; a similar award is made to a Teaching Assistant for the same purpose. Research productivity is measured by numbers of substantial papers in refereed technical journals, external research grants, graduate students supervised, and special awards from professional societies. Service to departments, the College and the University through faculty committees, and positions of leadership (committee chair), helps determine the service component. Public service includes membership on various government and civic boards, and on committees and leadership positions in professional societies.

4. **Academic Support Units**

List the names and titles of the individuals responsible for each of the units that teach courses required by the program being evaluated, e.g., mathematics, physics, etc.

- Mathematics: Dr. Peter Trapa, Chair; Associate Chair, Dr. Nick Koervarr
- Physics: Dr. Carleton DeTar, Chair; Dr. Christoph Boehme, Associate Chair
- Chemistry: Dr. Cynthia Burrow, Chair; Associate Chair
- Mining Engineering: Dr. Michael Nelson, Chair

5. **Non-academic Support Units**

The University Library System:

The University Library System is adequate to support undergraduate teaching and the research needs of faculty and graduate students. The University of Utah has three libraries on its campus: S. J. Quinney Law Library, Spencer S. Eccles Health Sciences Library, and J. Willard Marriott Library. The Marriott Library is the library used most by engineering faculty and students.

The Marriott Library currently has more than 3.5 million books and over 11,000 serials subscriptions. Through the regional “Utah Academic Library Consortium” students, faculty, and
staff have reciprocal borrowing privileges at other colleges and universities throughout the state of Utah. The library is five to ten minutes walking distance from Metallurgical Engineering department. The library is open 111 hours per week as follows: M-Th 7am-1am, Friday 7am-9pm, Saturday 9am-9pm, and Sunday noon-1am.

Marriott Library provides access to numerous online resources. These resources include article and physical-property databases, digital full-text journals, and a growing collection of e-books to support campus and distance education. The library’s e-book collection, including many online handbooks, is currently being developed among several products: EbscoHost, EBL, ebrary, Knovel, CRC, and Safari. Engineering related books are found in all of these collections.

The library’s Interlibrary Loans Department will borrow almost anything the user might need to support their academic program. The library offers the “Utah Article Delivery Service”, which will quickly deliver requested articles to a researcher’s desktop. It also has a policy of quickly obtaining copies of almost any engineering standard needed by faculty or graduate students (ASTM, ANSI, ASME, ISO, etc.). Engineering standards are purchased as needed with either faculty or librarian approval.

The library’s Education Services Department exists to promote information and computer literacy among students, faculty, and staff. Numerous special short courses are taught each term to cover basic library skills, research strategies, use of the online catalog, widely used software programs, and other electronic resources.

Librarians provide in-class instruction for library research and writing assignments, and have created many dozens of online guides to assist students with all aspects of library research and the use of information technology. Each department has a guide directing students to the best resources in that discipline. Examples of library support include the semi-annual Dissertation Bootcamp for students writing theses or dissertations, creation of the quiet Graduate Reading Room and presentation practice rooms, and numerous one-on-one consultations.

The library has provided space to create a Faculty Center for programs that serve faculty and students. The Writing Program, the Digital Scholarship Lab and the Statistics Consultation Service provide support for student projects. Faculty are supported by the Center for Teaching and Learning Excellence, the Teaching and Learning Technologies Center and the Grant Development Service. A Large-Data Repository is currently under development to archive and share faculty research data.

Through its Faculty Center the library provides teaching faculty with technical assistance in creating online course content. Due to the cost of equipment and software this is not a free service but grant money encouraging the development of online courses, and online reserve materials for regular courses, is available. The Faculty Center works with faculty to create the exact course content requested, including content from new audio and video studios. It helps instructors with all course-related uses of Canvas (the online-course software of the university).

The “Knowledge Commons” in the Marriott Library offers audiovisual and computing resource and assistance. More than 500 networked computers give electronic access to information held worldwide. Additionally, hundreds of software packages are available to students including AutoCAD, LabVIEW, Maple, Mathematica, SAS and others.

The Knowledge Commons offers many specialty software packages of interest to engineering students and faculty. The library also operates three campus computing labs located in residence
halls. The Marriott Library and all computing labs work closely with faculty to purchase media-materials and software to support course curricula (ChemCAD, Maple, CADvance, Programming Language software, etc).

Engineering related video and CD-ROM resources are requested in the Knowledge Commons where equipment for these formats is available. Microfiche are also requested at the Knowledge Commons for the same reason. Some databases, such as Ceramics Phase Diagrams, are loaded on student computers for use with class assignments. The library has completed a digital authoring studio to aid student groups and faculty in their digital authoring endeavors. This studio has high-end audio and video authoring tools.

The Knowledge Commons is operated by 9 librarians, as well as numerous technical support personnel. All librarians provide reference help for patrons at the desk, quick assistance over the phone, online assistance via Chat Reference, or in-depth consultations by appointment. The librarians are available for course-integrated instruction sessions, and specialty classes tailored to the college’s specific needs. A patent specialist is available in the library for instruction and one-on-one assistance.

Each academic department is assigned a librarian as a liaison, instructor and general problem solver while another 2-3 librarians are also involved in instruction and collection development.

**Library Support for Engineering Programs**

The last five years has seen considerable movement among publishers to offer much more content in electronic formats. Publishers are now packaging both their serials and book collections for purchase. In response to the marketplace, the library has reorganized its individual department liaisons into teams that make decisions on packaged content.

**Books**

Below are the Total Book Holdings of the Marriott Library. The total, counting free resources, is approximately 5,000,000 books. This total does not include HathiTrust’s 4,977,612 public domain volumes, which is also provided by the library.

<table>
<thead>
<tr>
<th>Total Books Added (5-Yr)</th>
<th>232,241</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Physical Titles</td>
<td>2,699,654</td>
</tr>
<tr>
<td>Total eBook Titles</td>
<td>817,263</td>
</tr>
<tr>
<td><strong>Total Library Books</strong></td>
<td>3,516,917</td>
</tr>
</tbody>
</table>

**NEW BOOKS ADDED**

<table>
<thead>
<tr>
<th></th>
<th>2014</th>
<th>2013</th>
<th>2012</th>
<th>2011</th>
<th>2010</th>
<th>5-Yr Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Titles</td>
<td>5,444</td>
<td>7,550</td>
<td>7,553</td>
<td>9,588</td>
<td>11,006</td>
<td>41,141</td>
</tr>
<tr>
<td>eBooks Titles</td>
<td>32,095</td>
<td>38,537</td>
<td>40,092</td>
<td>38,384</td>
<td>41,992</td>
<td>191,100</td>
</tr>
</tbody>
</table>

176
While the figures above represent holdings for all collections, below are total physical books and ebooks added to the collection in Engineering, and supporting disciplines, during the last five years.

<table>
<thead>
<tr>
<th>BOOKS ADDED</th>
<th>Engineering</th>
<th>Chemistry</th>
<th>Math</th>
<th>Physics</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>2,459</td>
<td>195</td>
<td>2,273</td>
<td>402</td>
</tr>
<tr>
<td>2013</td>
<td>2,919</td>
<td>273</td>
<td>2,623</td>
<td>518</td>
</tr>
<tr>
<td>2012</td>
<td>2,980</td>
<td>279</td>
<td>1,589</td>
<td>537</td>
</tr>
<tr>
<td>2011</td>
<td>2,643</td>
<td>291</td>
<td>1,146</td>
<td>550</td>
</tr>
<tr>
<td>2010</td>
<td>3,057</td>
<td>303</td>
<td>1,816</td>
<td>550</td>
</tr>
<tr>
<td>5 Year Total</td>
<td>14,058</td>
<td>1,341</td>
<td>9,447</td>
<td>2,557</td>
</tr>
</tbody>
</table>

Serials
The Library subscribes to over 11,000 journals and has full or partial access to over 50,000 serials. Of journal subscriptions, roughly 3,500 are in engineering subjects. This means approximately 25-30% of library serials subscriptions support engineering and related disciplines.

During the past five years, publishers have moved to packaging serials subscriptions. Now it is no longer possible to determine the real cost of individual journals and calculate spending by department or college. Below are the Journal Packages that are currently purchased for Engineering and supporting disciplines. Library subscriptions to print serials are currently negligible.

**2013-2014 Ejournals Packages Supporting the Engineering Programs:**

<table>
<thead>
<tr>
<th>ONLINE PACKAGES</th>
<th>PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACS American Chemical Society</td>
<td>$97,060.00</td>
</tr>
<tr>
<td>American Mathematical Society</td>
<td>$2,918.00</td>
</tr>
<tr>
<td>Association for Computing Machinery</td>
<td>$4,813.00</td>
</tr>
<tr>
<td>ACM</td>
<td></td>
</tr>
<tr>
<td>Cambridge University Press</td>
<td>$61,572.00</td>
</tr>
<tr>
<td>Elsevier Package</td>
<td>$773,915.51</td>
</tr>
<tr>
<td>Freedom Collection Elsevier</td>
<td>$104,753.00</td>
</tr>
<tr>
<td>GeoScience World</td>
<td>$13,738.00</td>
</tr>
<tr>
<td>IOP Science</td>
<td>$110,518.00</td>
</tr>
<tr>
<td>Nature Publishing Group</td>
<td>$131,977.00</td>
</tr>
<tr>
<td>Oxford University Press</td>
<td>$60,975.83</td>
</tr>
<tr>
<td>RSC Gold Package Upgrade</td>
<td>$71,126.64</td>
</tr>
<tr>
<td>SPIE Digital Library</td>
<td>$13,252.00</td>
</tr>
</tbody>
</table>
Wiley Online Collection

$537,998.00
$1,984,616.9

Total

8

**Article delivery**

This includes both physical and electronic delivery of materials, primarily through Interlibrary Loans which operates a Document Delivery service to the desktop (print) or mailbox.

**2013/2014 ARTICLE DELIVERY EXPENDITURES**

<table>
<thead>
<tr>
<th>PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>$11,134.00</td>
</tr>
<tr>
<td>$462.00</td>
</tr>
<tr>
<td>$760.00</td>
</tr>
<tr>
<td>$3,434.9</td>
</tr>
<tr>
<td>$130.50</td>
</tr>
<tr>
<td>$3,434.9</td>
</tr>
<tr>
<td>$15,921.49</td>
</tr>
</tbody>
</table>

**Databases**

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>DATABASE EXPENDITURES for ENGINEERING and SUPPORTING DISCIPLINES</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013/14</td>
<td></td>
</tr>
<tr>
<td>Engineering</td>
<td></td>
</tr>
<tr>
<td>GeoRef</td>
<td>$ 8,625.00 6 $ 7,200.00</td>
</tr>
<tr>
<td>Biological Sciences</td>
<td>$ 4,242.00</td>
</tr>
<tr>
<td>BIOSIS</td>
<td>$ 37,502.00</td>
</tr>
<tr>
<td>IEEE Xplore</td>
<td>$ 144,395.00</td>
</tr>
<tr>
<td>MADCAD</td>
<td>$ 1,206.00</td>
</tr>
<tr>
<td>NTIS</td>
<td>$ 7,285.00</td>
</tr>
<tr>
<td>Knovel</td>
<td>$ 41,515.00</td>
</tr>
<tr>
<td>Metadex</td>
<td>$ 4,242.00</td>
</tr>
<tr>
<td>Total</td>
<td>$ 249,012.00 $ 7,200.00</td>
</tr>
</tbody>
</table>

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### Chemistry

<table>
<thead>
<tr>
<th>Resource</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cambridge Structural Database</td>
<td>$3,350.00</td>
</tr>
<tr>
<td>ChemNetBase</td>
<td>$7,275.00</td>
</tr>
<tr>
<td>Kirk-Othmer Encyc. Of Chemical Technology</td>
<td>$4,561.37</td>
</tr>
<tr>
<td>Merck Index</td>
<td>$2,400.00</td>
</tr>
<tr>
<td>SciFinder Scholar</td>
<td>$116,354.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$133,940.37</strong></td>
</tr>
</tbody>
</table>

### Computer Science

<table>
<thead>
<tr>
<th>Resource</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computing Reviews</td>
<td>$1,260.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$1,260.00</strong></td>
</tr>
</tbody>
</table>

### Physics

<table>
<thead>
<tr>
<th>Resource</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspec</td>
<td>$52,141.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$52,141.00</strong></td>
</tr>
</tbody>
</table>

### Mathematics

<table>
<thead>
<tr>
<th>Resource</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>MathNetBase</td>
<td>$2,835.00</td>
</tr>
<tr>
<td>MathSciNet</td>
<td>$8,885.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$11,720.00</strong></td>
</tr>
</tbody>
</table>

### Interdisciplinary

<table>
<thead>
<tr>
<th>Resource</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scopus (includes Compendex)</td>
<td>$75,600.00</td>
</tr>
<tr>
<td>Web of Science/Knowledge</td>
<td>$116,973.00</td>
</tr>
<tr>
<td>Dissertation Full</td>
<td>$22,890.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$215,463.00</strong></td>
</tr>
</tbody>
</table>

### Total for All Resources listed

<table>
<thead>
<tr>
<th>Resource</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total for All Resources listed</strong></td>
<td><strong>$670,736.37</strong></td>
</tr>
</tbody>
</table>

### Software support

Over 350 software packages, including the ones with Engineering applications are in use. Besides major software suites from major software publishers such as Microsoft and Adobe, the library purchases many specialty software programs to enhance all stages of knowledge creation and presentation. This is a small selected list of specialty software supporting engineering.
University College Advising Center: At the University College Advising Center undeclared and pre-major students learn about academic programs, University policies and procedures, selecting classes, exploring majors, and other education-related concerns.

Career Services: UCareerLink helps students and employers find each other. It also allows Career Services to communicate with students about events such as career fairs, job postings, and interview schedules. Counselors are available for quick questions, and by appointment within a few days for current and recent graduates of the University.

Counseling Center: The University has a Counseling Center to assist to students, staff, and faculty with a variety of personal, academic and career concerns. Its approach is collaborative, goal-oriented, and multiculturally sensitive. The center attempts to help individuals develop more personal awareness and to learn skills you necessary for success at the University of Utah. It is a professional organization that has been of help to some of our students.

Disability Center: The Center for Disability Services provides accommodations and support for the educational development of students with disabilities. It strives to improve understanding
and acceptance of students with disabilities throughout the University community. The center
gives direct assistance to students to encourage and enhance their independence, works
continually to develop and maintain an accessible physical environment, and endeavors to create
a supportive psychological environment so that students can achieve their educational objectives.

6. **Credit Unit**

One semester credit normally represents one class hour or three laboratory hours per week. One
academic year normally represents at least 28 weeks of classes, exclusive of final examinations.
Table D-1. Program Enrollment and Degree Data

Name of the Program

<table>
<thead>
<tr>
<th>Academic Year</th>
<th>Enrollment Year</th>
<th>Total Undergrad</th>
<th>Total Grad</th>
<th>Degrees Awarded</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>4th</td>
</tr>
<tr>
<td>Current Year</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FT</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>PT</td>
<td>4</td>
<td>1</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FT</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>PT</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td></td>
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<td></td>
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<td>FT</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td>PT</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FT</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>PT</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FT</td>
<td>3</td>
<td>5</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>PT</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>

Give official fall term enrollment figures (head count) for the current and preceding four academic years and undergraduate and graduate degrees conferred during each of those years. The "current" year means the academic year preceding the on-site visit.

FT--full time
PT--part time
### Table D-2. Personnel

**Name of the Program**

Year: ________

<table>
<thead>
<tr>
<th>Category</th>
<th>HEA COUNT</th>
<th>FTE²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FT</td>
<td>PT</td>
</tr>
<tr>
<td>Administrative²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Faculty (tenure-track)³</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Other Faculty (excluding student Assistants)</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Student Teaching Assistants⁴</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Technicians/Specialists</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Office/Clerical Employees</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Others⁵</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Report data for the program being evaluated.

1. Data on this table should be for the fall term immediately preceding the visit. Updated tables for the fall term when the ABET team is visiting are to be prepared and presented to the team when they arrive.

2. Persons holding joint administrative/faculty positions or other combined assignments should be allocated to each category according to the fraction of the appointment assigned to that category.

3. For faculty members, 1 FTE equals what your institution defines as a full-time load

4. For student teaching assistants, 1 FTE equals 20 hours per week of work (or service). For undergraduate and graduate students, 1 FTE equals 15 semester credit-hours (or 24 quarter credit-hours) per term of institutional course work, meaning all courses — science, humanities and social sciences, etc.

5. Specify any other category considered appropriate, or leave blank.
Signature Attesting to Compliance

By signing below, I attest to the following:

That the Geological Engineering program in the Department of Geology & Geophysics has conducted an honest assessment of compliance and has provided a complete and accurate disclosure of timely information regarding compliance with ABET’s *Criteria for Accrediting Engineering Programs* to include the General Criteria and any applicable Program Criteria, and the ABET Accreditation Policy and Procedure Manual.

Francis H. Brown
Dean's Name (As indicated on the RFE)

Signature Date