

ABET
Self-Study Report
for the
Bachelor of Science in Civil Engineering
at
University of Colorado Boulder
Boulder, CO

July 1, 2023

CONFIDENTIAL

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**Program Self-Study Report
for
EAC of ABET
Reaccreditation**

BACKGROUND INFORMATION

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B. Program History

The Bachelor of Science in Civil Engineering (CVEN) degree at the University of Colorado Boulder (CU) is offered through the Department of Civil, Environmental, and Architectural Engineering (CEAE), which resides within the College of Engineering and Applied Science (CEAS). Civil Engineering was one of two engineering majors offered in 1893 when the School of Applied Science was first established as part of CU. The Bachelor of Science degree in Civil Engineering was first accredited in 1936. In the 2017-2018 general review by the Engineering Accreditation Commission of ABET, our program received a Next General Review with accreditation through Sept. 30, 2024.

The CVEN program at the University of Colorado Boulder is unique. The University of Colorado Boulder is a Tier I research institution. It is the top-ranked institution of higher education throughout the Rocky Mountain region. Our CVEN program was recently ranked 17th among public undergraduate programs and 10th among public graduate programs by U.S. News and World Report for 2023. Unlike other programs that may offer two or three areas of specialization, ***our CVEN program affords students the opportunity to study five***

major areas, including geotechnical engineering, water resources engineering, construction engineering and management, structural engineering, and environmental engineering. Our hands-on, project-based courses are attractive to students. Graduates from our program are in very high demand from employers, many of whom are University of Colorado Boulder alumni, along Colorado's front range and beyond.

No *significant* curriculum changes were implemented since the 2017-2018 academic year.

The following changes were made by the College of Engineering and Applied Science that were implemented in the CVEN curriculum in 2020:

- CHEN 1211 General Chemistry for Engineers (4 credits) and CHEM 1221 General Chemistry Lab for Engineers (1 credit) were replaced with CVEN 1201 General Chemistry for Engineers I (4 credits) and CHEM 1114 Lab in General Chemistry I (1 credit). The change better aligned the chemistry courses with the needs of the majors.

The following changes were made to the CVEN curriculum for Fall 2020. Changes were approved by CEAE faculty on 2/19/2020.

- The option of fulfilling the Engineering Geology requirement with another Basic Science Elective was removed. Now CVEN 3698 Engineering Geology is required. This change was made because students need the content from Engineering Geology for geotechnical engineering. Also, the flexibility was intended to allow students to choose a science course that aligned with their intended career path; however, most students who took a different Basic Science elective chose a course to which they could apply AP Biology credit, which left them less prepared for geotechnical engineering (having not taken Engineering Geology) and no better prepared for their intended career path.
- The computing course (CSCI 1320, 4 credits) was replaced with CSCI 1200 Intro to Computational Thinking (3 credits) and a new course CVEN 2107 Excel and Matlab Primer (1 credit), because CSCI 1320 is no longer offered. CSCI 1200 teaches Python, so students learn structured programming. However, the students would no longer have formal training in Excel and Matlab, which are important tools for the CVEN curriculum. Therefore, a new 1-credit course on Excel and Matlab was added. CSCI 1200 is only offered in the Fall semester, so computing was moved to the first semester (CSCI 1320 was taken in the second semester). The Excel and Matlab primer should be taken after CSCI 1200 and closer to the time when the students would need to apply their Excel and Matlab skills, so CVEN 2107 is taken in the fourth semester.
- GEEN 1400 Engineering Projects was moved from the first semester to the second semester to accommodate changes to the computing class.

C. Options

All students in the CVEN program must take foundational courses in **five** civil engineering proficiency areas, including geotechnical engineering, water resources engineering, construction engineering and management, structural engineering, and environmental engineering. The current civil engineering curriculum also requires undergraduate students to

select a minimum of **three** out of **five** civil engineering areas in which to take a proficiency course, which are advanced courses beyond the foundational courses. These include a course in geotechnical engineering (CVEN 3718 Geotechnical Engineering II), water resources engineering (CVEN 4333 Engineering Hydrology), construction engineering and management (CVEN 3256 Construction Equipment and Methods), structural engineering (CVEN 4545 Steel Design or CVEN 4555 Reinforced Concrete Design), or environmental engineering (CVEN 3424 Water and Wastewater Treatment). Students then have the option to specialize in **one** civil engineering area by taking technical elective courses in one of these areas. Please see **Program Criteria** for more information.

D. Program Delivery Modes

The bulk of the required Civil Engineering curriculum is provided to students via courses offered between 8 am – 5 pm on weekdays on the Boulder campus as traditional lecture/laboratory/recitation courses. Humanities and social science electives may be taken as web-based or distance education courses through CU Continuing Education, but that is not common. Some technical electives could also potentially be taken as web-based or distance education courses. The program offers the opportunity for students and encourages them to participate in internships and Cooperative Education (“co-op”) program, but co-ops do not fulfill any of the curriculum requirements and few students participate.

E. Program Locations

The program is regularly offered at the University of Colorado Boulder main campus. Students may participate in Study Abroad programs offered by the University and transfer some of these credits into the major. Students also sometimes take summer courses from other institutions that can be transferred into the major, subject to the approval of the departmental transfer course evaluator.

F. Public Disclosure

The Program Educational Objectives (PEOs) and student outcomes (SOs) are published in the catalog of the University of Colorado Boulder. These are also published on the website of the CEAE Department (https://www.colorado.edu/ceae/about/undergraduate-degrees/educational-objectives-outcomes#civil_engineering-367). Annual student enrollment data (including demographic data), retention and graduation data, post-graduate career outcomes, and rankings are posted on the College of Engineering & Applied Science (CEAS) website (<https://www.colorado.edu/engineering/facts-figures>).

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

The previous 2017-18 ABET evaluation identified no deficiencies, weaknesses, or concerns.

GENERAL CRITERIA

CRITERION 1. STUDENTS

Undergraduate admissions are handled by the College and the Campus admissions office. Individual departments do not have any input into student admission decisions except to provide input on target enrollments for the College's enrollment management strategy.

A. Student Admissions

In the first-year freshmen admission process, the College seeks to admit applicants with a high probability of successfully completing their undergraduate engineering degree program at the University of Colorado, Boulder. The Office of Admissions and the College consider the following factors in making admission decisions:

- Evidence of scholastic ability and accomplishment as demonstrated by grade point averages, tests of scholastic aptitude and achievement (ACT or SAT), class rank, grades earned in courses directly applicable to an engineering academic program, and essays.
- Personal motivation and academic success as demonstrated by trends in the student's academic record, rigor, and challenge of coursework, success in the academic community, ability to balance academic and personal interests, and letters of recommendation.

Beginning for the fall 2020 class, CU Boulder adopted a "test score optional" admissions policy. Under this policy, students do not need to submit test scores to be considered for admission. The College implemented a rubric to quantify an applicant's level of academic rigor, leadership experience, and shown interest in their desired major. These scores, along with the holistic factors described above, are used to determine whether a student is admissible to their desired major within the College. For fall 2022, 66% of students submitted test scores. The College set a policy that a student's test scores can only help their admissibility, not harm it. If a student was not admissible using their test scores, they would be evaluated using the "test score optional" rubric and criteria.

If a student is not admissible to their desired major, they are reviewed for the [Program of Exploratory Studies](#) at the Campus level. The Program of Exploratory students allows students the opportunity to explore all majors on the CU Boulder campus and support to transfer into their desired College and major once meeting academic requirements.

The College is committed to increasing the quality of its programs, in part by increasing the holistic diversity of its students (ethnic, gender, geographical, cultural, socio-economic and

first-generation students). This commitment is reflected in the admissions process and the special programs established to support these students.

The following mean average information is provided from prior first-year classes in the College of Engineering and Applied Sciences:

New Studs Entering in	High School Rank	HS GPA	ACT Math	ACS Engl.	SAT Math	SAT Crit. Read	# of New Studs
Fall 2022	86%	3.94	30.1	30.5	693	670	1083
Fall 2021	89%	3.92	30.6	30.7	703	672	1022
Fall 2020	88%	3.9	30.1	30.2	686	654	1197
Fall 2019	89%	3.91	30.5	30.8	699	665	946
Fall 2018	87%	3.91	30.7	31.0	701	668	923
Fall 2017	87%	3.93	30.3	30.1	696	664	850

For more information about first-year admissions, see <http://www.colorado.edu/admissions>

Due to large increases in the size of the incoming freshman classes, and heightened student interest in specific majors, the College has implemented several enrollment management policies over time. Currently, when students apply to the College of Engineering and Applied Science (CEAS) from high school, they may indicate to enter the College as “open option” (unsure of engineering major), or they may select a preliminary engineering major.

Sometime after completion of the first semester, and by the eighth week of the second semester, all students should finalize their choice of major in the College. Students wishing to make a major change within the College use the Change of Major Form to finalize their choice of major.

Students are encouraged to confirm their choice of major by the middle of their second semester (before they enroll in coursework for the third semester). If a change is desired, students follow the procedure outlined at <https://www.colorado.edu/engineering-advising/majorchange>.

B. Evaluating Student Performance

CU Boulder employs an online degree audit system which monitors student progress for all Civil Engineering B.S. requirements, including individual course requirements and cumulative credit hour totals in each category (Humanities & Social Sciences, Math and Basic Science, Free Electives, Technical Electives, and Civil Engineering). Each requirement is displayed as incomplete, in progress, or complete. The degree audit includes all transfer coursework, AP and IB credit, completed coursework, and coursework in progress. The undergraduate advising team reviews each student’s degree audit periodically and makes any necessary adjustments, such as when exceptions or substitutions are approved via petition.

Course pre-requisites, co-requisites, and other restrictions (class level, major, etc.) are automatically enforced by the course registration system - students cannot enroll in a course unless all pre- and co-requisites are either completed (with a grade of C- or higher) or in progress. Students currently enrolled in a pre- or co-requisite course are enrolled on a conditional basis. The curriculum coordinators in each department monitor student grades at the end of each semester, via Enrollment Requirement Rosters built into the registration system. Conditionally enrolled students who do not pass a pre-requisite course with a grade of C- or higher are administratively dropped from the subsequent course. Academic advisors also monitor grades for their assigned rosters and work with students to adjust their course schedules if a course must be repeated. Students may request to have a pre-requisite or co-requisite waived by the course instructor. The CEAE Department requires students to obtain such permission in writing.

Students are awarded grades on a course-by-course basis. For each course, students earn grades A (4 quality points) through F (0 quality points), augmented with plus (+) and minus (-) which add or subtract 0.3 quality points from the letter grade they accompany (except that no A+ is available). These grades are used to compute a grade point average (GPA) every semester and an overall cumulative GPA for courses taken at CU. Grading policies are detailed at <http://www.colorado.edu/engineering-advising/get-your-degree/academic-expectations-policies> and at <https://catalog.colorado.edu/undergraduate/credits-grading/>. Course dossiers contain information describing how individual courses are graded.

Students are subject to the University's Academic Standing policy (<https://catalog.colorado.edu/undergraduate/academic-records/#academicstandingtext>), which is managed by the University's Registrar's Office. Students need a minimum CU GPA of 2.000 to stay in good academic standing.

C. Transfer Students and Transfer Courses

External Transfers:

External transfer students are admitted to the College of Engineering and Applied Science through the CU Boulder Admissions Office, based on criteria set by the College. Like the first-year freshman admission process, the College seeks to admit external and internal transfer applicants with a high probability of successfully completing their undergraduate engineering degree program at the University of Colorado Boulder.

To qualify for admission as a new transfer student, the applicant must have completed a minimum of two semesters of college-level calculus and one semester of science (college chemistry and/or calculus-based physics). If the applicant has less than 24 semester credit hours, a high school transcript and other holistic admission review factors typically used in the freshman admission process will be used, in conjunction with the college transcript.

CEAS Competitive Transfer Admission Criteria:

- 3.00 cumulative GPA. This includes all college-level coursework from any post-high school enrollment, though more recent coursework after a pause in academic enrollment can be used in lieu of older coursework.
- Completion of two semesters of college-level calculus AND one semester of calculus-based physics OR college-level chemistry
- Grades in math and science courses should be B or better

Additionally, The College of Engineering and Applied Science guarantees admission to any of its baccalaureate degree programs to students transferring from a Colorado Community College.

Guaranteed Admission Criteria:

1. At least two full-time semesters (or 24 credit hours) at a Colorado Community College must be satisfactorily completed immediately prior to the transfer.
2. Completion of **two** semesters of college-level Calculus
3. Complete **one** of the following science courses:
 - PHY 211 – Physics 1
 - PHY 212 – Physics 2
 - CHE 111 – General College Chemistry 1
 - *CHE 112 strongly recommended for Chemical, Chemical & Biological, and Environmental Engineering applicants*
 - Complete **one** engineering course from the following list:
 - EGG/EGT 140
 - EGG 145
 - CSC 160
 - EGG 106 AND EGG 151
 - EGG 211
4. **All** grades in math, science, engineering, and computer science courses of B or better.
5. Cumulative college GPA of 3.00

The College of Engineering and Applied Science and the Colorado Community College System have an articulation agreement for admission, as well as select Associate of Engineering Science (AES) degree pathways to specific engineering departments. Currently, Mechanical Engineering and Civil Engineering are articulated, with plans to include Architectural, Electrical, and a general engineering pathway.

There are also several direct equivalent engineering courses that allow community college students to transfer basic math, science and certain engineering courses to CU Boulder. The participating institutions agree to the agreement's policies governing the transfer of credit among Colorado public institutions for students pursuing baccalaureate majors in the College of Engineering and Applied Science. Further, the College of Engineering and Applied Science has special agreements with select Colorado Community Colleges where more

advanced engineering and computer science courses are offered for enhanced degree applicability. Please see the following for these agreements:

- Colorado Community College Resources
- <https://www.colorado.edu/engineering/CCCSTransfer>
- Basic Math, Science, Engineering and Computer Science Courses by major:
- <https://www.colorado.edu/engineering/courses-will-transfer>

Accelerated Admission Pathway:

Some students decide to transfer externally to CU Boulder before completing all of the transfer admission requirements, but are interested in engineering. For students who have taken at least one Math course completed with B or better (Calculus 1 or higher) or in-progress, no other prerequisites listed in our admission criteria and all other math/science courses are B or better, we allow these students to be admitted to our Accelerated Admission Pathway.

We admit these students to the Program in Exploratory Studies (PES) where they complete the remaining prerequisites they needed as an external applicant in one semester to be directly admitted. If at the end of the semester they meet the external admission criteria, we allow them direct admission to the major of their choice and they do not need to follow the Intra-University Transfer (IUT) pathway. In the event they do not meet that criteria, they can still internally transfer via the IUT criteria.

Internal Transfers:

Internal transfer applicants (degree-seeking students from another college/school at the CU Boulder campus) are admitted by the College, via the Intra-University Transfer (IUT) process. The IUT process allows CU Boulder students to transfer into the College if they complete a set of requirements that demonstrate their ability to be successful in an engineering curriculum. As with external transfers, IUT students must complete a minimum of two semesters of calculus and two semesters of science. CU cumulative and technical GPAs of at least 2.7 are required. The full set of IUT requirements is posted at:

<https://www.colorado.edu/engineering-advising/intra-university-transfer-iut-college-engineering-applied-science-bachelors-degree-programs>

D. Advising and Career Guidance

Staff Advising Program

The College of Engineering and Applied Science (CEAS) understands the importance of good advising in supporting student development and engagement. All baccalaureate students are advised by professional academic advising staff in the CEAS Student Support & Advising Services (SSAS) unit (<https://www.colorado.edu/engineering-advising>). The Civil, Environmental & Architectural Engineering Department has an embedded team of three advisors (two full-time academic advisors, and an Area Director who supervises advisors in multiple programs) that support both Civil Engineering and Architectural Engineering

students. Each student has an assigned primary advisor but may meet with other members of the advising team during drop-in hours or when their assigned advisor is out of the office.

The advising team creates a degree planning worksheet for each student based on the Civil Engineering block diagram, which is used to help students with long-term planning and course selection for each semester. This degree planner is shared with the student via Google Drive, so the student can access it at any time. These degree planners are used in conjunction with the online degree audit to help students monitor their degree progress and stay on track for their intended graduation date.

Students are encouraged to meet with their professional staff advisor regularly to discuss the student's academic progress and their planned future courses in the major. The academic advisor also provides guidance and referrals regarding additional majors, minors, certificates, Bachelor's – Accelerated Master's (BAM) programs, study abroad planning, extracurricular activities, tutoring and academic support, academic standing, resources for personal support, etc.

The CEAS has a robust onboarding program for new advisors and supports ongoing professional development and growth for all advisors. This includes training on policies and procedures, advising expectations and best practices, and engagement in diversity, equity, and inclusion work to best serve our students. SSAS professionals meet regularly to share information, discuss pertinent issues, and identify ways to improve the student advising experience. A comprehensive student-facing advising website at www.colorado.edu/engineering-advising has details on policies, procedures, forms, etc.

Students are provided with several resources to help them understand degree requirements. The curriculum of record is described in the annual University Undergraduate Catalog (<https://catalog.colorado.edu/undergraduate>). This is supplemented by university and college web sites describing policies, along with the Civil Engineering curriculum website (<https://www.colorado.edu/ceae/current-students/undergraduate-studies/civil-engineering>) and CEAE Graduation Requirements & Advising Guide (<https://www.colorado.edu/ceae/current-students/undergraduate-studies/graduation-requirements-advising-guide>).

Student contacts with advisors may include pre-scheduled individual advising meetings, drop-in meetings, group advising sessions, and/or email correspondence. Students have options to meet with advisors in-person or virtually. Students early in their academic career at CU, reaching certain milestones in the curriculum, not in good academic standing, etc. are typically required to meet with their academic advisor. This is managed by having an “advising hold” placed on their student record (which prohibits course enrollment until the student connects with the advisor).

Records of student meetings are stored in the campus-wide Buff Portal Advising (<https://www.colorado.edu/buffportaladvising/>) system, which is used for offering advisor meeting availability to students, communicating with student advisees, and logging meeting notes.

The Registrar's Degree Audit system assists both students and advisors in monitoring fulfillment of degree requirements. Student petitions, Independent Study Agreements, and other student records involving department/program review, are maintained by academic advisors in digital format. More general records are maintained by the CEAS Dean's Office (foreign language exam results, change of major forms, etc.) or the Registrar's Office (e.g., course enrollments, approved grade changes, student transcripts and degrees, etc.).

Professional Mentorship and Advising Program

In academic year 2022-2023, the department kicked off a pilot professional mentorship program in partnership with the college and the CU Alumni Association. The program is hosted on the Forever Buffs Network (FBN) platform for CU alumni. While the program is therefore restricted to alumni mentors, it is an approach that allows any undergraduate student to sign up for a mentor if they choose to do so.

Mentor/mentee matches are made through a mixed manual and automated approach based on what is known about the goals of the students, mentors, and information included in their FBN profiles. Matches are made in the fall semester and then mentorship pairs fill out a contract together that allows them to define and agree upon meeting time, modes, and topics. Training is provided for the mentors and mentees via the FBN platform.

The department collaborated with the college to set up an engineering subgroup on the FBN platform. All CEAE mentorship pairs are part of this group. They receive information in addition to that provided by the CU Alumni Association such as engineering-specific mentorship questions, and links to professional accomplishments and project case studies.

In the 2022-2023 academic year, the campus-wide mentorship program had 158 active mentorship relationships. The College of Engineering and Applied Science has 70 relationships, 39 of which include civil, environmental, or architectural engineering students. The pilot program ends in May of 2023 at which time feedback about the program will be collected from mentees and mentors. Adjustments will be made as needed to improve program efficacy prior to the 2023-2024 academic year.

Faculty Advising

Starting in the 2018-2019 academic year, the CEAE Department transitioned to a new model for academic advising and mentoring. Prior to this, the advising model was as follows: freshman and sophomore students were required to meet every semester with the staff advisor for their major. Juniors selected a faculty advisor in the fall of their junior year and were required to meet with their faculty advisor every semester until graduation. Faculty advisors conducted 20-minute individual meetings with each student over a designated two-week period each semester.

At our last ABET site visit in Fall 2017, students indicated that they wished they had more time to talk about careers with their faculty advisors, instead of just spending the time picking classes. In response to this feedback, the architectural engineering program piloted a new advising model in Spring 2020. Under this system, the staff advisor took over

responsibility for advising all AREN students regarding their degree requirements and making sure they were enrolling in the correct classes every semester. Faculty advisors were renamed “faculty mentors” to align with other programs in the College, and were asked to focus more on career-related discussions with students. This included career options, choice of technical electives, internships, graduate school, research opportunities, etc.

The pilot program received no negative feedback from students or faculty, and was expanded to the civil engineering program in Spring 2020. Once the entire CEAE Department was following the same advising model, it made additional changes possible. Faculty now have the option to conduct their mentoring meetings via individual appointments, drop-ins, or group sessions based on their preferences. Some faculty have reported that group sessions give the opportunity for more discussion among the students, and students have the option to request an individual meeting if they prefer.

Faculty mentors offer students support for technical questions, research opportunities, graduate school, independent study, career directions, course content, and guidance on electives depending upon the student’s interests and future plans. The CVEN Faculty Director serves as the default faculty advisor for freshmen and sophomores, but students may be referred elsewhere if they have questions relating to a particular faculty member’s area of expertise. As juniors, students choose a faculty mentor who aligns with their career interests, and are required to meet with their mentor every semester thereafter. Faculty mentors have the option to schedule individual meetings, drop-in hours, or group meetings with their mentees, although students can always request an individual meeting if they prefer.

Academic coaches (<https://www.colorado.edu/engineering-advising/academiccoaching>) support students by meeting with them to delve into topics such as motivation, time management and prioritization, strategies for learning, studying, and test preparation, and establishing supportive study habits, etc.

Advising and tutoring are also offered by the Broadening Opportunity through Leadership and Diversity (BOLD) Center (www.colorado.edu/engineering/bold), which promotes scholarship, leadership, and community-building among students who are traditionally underrepresented in engineering. In addition, the Engineering Ambassadors (<https://www.colorado.edu/engineering-advising/ambassadors>) peer advising and mentoring program provides convenient student-to-student assistance and guidance.

The College of Engineering and Applied Science (CEAS) is committed to the career and professional development success of its students. Branded as ProReady, and led by the Sr. Director of Student Professional Development, the ProReady portfolio works to help students to become workforce ready by helping them chart their career path, gain relevant experience, and grow their professional network. Full information can be found here <https://www.colorado.edu/engineering/proready>

One component of ProReady is the Engineering Career Services team, comprised of career advisors specifically dedicated to CEAS students. In partnership with the campus Career Services office, Engineering Career Services provides services including career advising appointments (with professional staff and peer mentors), career workshops, and a robust suite

of web-based resources (www.colorado.edu/engineering/career). Typical topics covered by the Engineering Career Services team include career/major exploration, effective application materials (resumes, cover letters, etc.), job/internship search strategy, career fairs and interviewing skills, and salary negotiations.

Within the Engineering Career Services team is our employer relations staff, who work directly with employers to connect them with students. In partnership with campus Career Services office, the employer relations staff help employers register for career fairs, schedule company information sessions and tables, post positions on Handshake, and connect with targeted student populations.

The second component of the ProReady portfolio is Active Learning, which focuses primarily on undergraduate research. CEAS provides a comprehensive suite of undergraduate research offerings from introductory (Spring Break for Research), intermediate (Discovery Learning Apprenticeship), to advanced (Summer Program for Research). Full information can be found at <https://www.colorado.edu/engineering/students/research>

The third component of the ProReady portfolio is International Programs. CEAS provides a plethora of opportunities for all students to study abroad, ranging from global intensive experiences (2-4 weeks), summer experiences, to full academic year experiences. CEAS students can take their required university Humanities & Social Science courses anywhere in the world or take technical courses in their major with our partner global institutions. Full information can be found at <https://www.colorado.edu/engineering-international/engineers-abroad>

The ProReady team also supports and promotes additional valuable professional development activities across CEAS. These programs include department-based career development initiatives, graduate school preparation, student leadership development, entrepreneurship, on-campus employment, and alumni engagement.

E. Work in Lieu of Courses

AP/IB Credit: See the Undergraduate Catalog for a [listing of AP and IB exam scores correlating to CU Boulder course equivalents](#)

Advanced Placement (AP). For students who have taken an Advanced Placement (AP) course in high school and who make the required score in the College Board's AP examination, college credit is granted by CU Boulder. If a student elects to take the equivalent college course, the credit for that course will replace the AP credit.

International Baccalaureate (IB). For students who make the required score in the IB examination, college credit is granted by CU Boulder. If a student elects to take the equivalent college course, the credit for that course will replace the IB credit.

College-Level Examination Program (CLEP). College credit may be earned for appropriate scores on CLEP examinations. A list of subjects in which CLEP examinations are accepted for CU Boulder can be found in the [Undergraduate Catalog](#). Individual degree programs

advise students on if and how earned CLEP credit may apply toward specific degree requirements.

Credit for DANTES Subject Standardized Tests (DSST) in the humanities, mathematics, physical science and social sciences areas may be granted for a score of 400 or above. Credit award and course equivalency information listed in this table applies only to degree programs completed entirely at the Boulder Campus.

Military Service: <https://www.colorado.edu/veterans/prospective-new-students/military-credit> Credit for military schooling, both for courses and for occupations, is evaluated upon receipt of Form DD 214, Service Separation Certificate, a Joint Services Transcript (JST) or a transcript from the Community College of the Air Force (CCAF). For military courses and occupations that have been approved for GT Pathways credit by the Colorado Department of Higher Education students will be awarded GT Pathways credit, which will fill General Education requirements in most, but not all, programs at CU Boulder. For qualifying scores at the American Council on Education (ACE) recommended cut scores on Defense Language Proficiency tests students will be awarded GT Pathways World Language credit (GT-AH4), which will fill General Education requirements, usually as a Humanities course, in most, but not all, programs at CU Boulder.

F. Graduation Requirements

To graduate with a Bachelor of Science degree from the College of Engineering and Applied Science, a student must meet all of the following minimum requirements:

1. The satisfactory completion of the prescribed and elective work in any curriculum as determined by the college and the appropriate academic department/program. A student must complete a minimum of 128 semester hours, of which the last 45 must be Boulder coursework earned after admission to the university and the college.
2. A University of Colorado cumulative grade point average of at least 2.000 for all courses attempted.
3. A separately computed grade point average, Major GPA, of at least 2.000. The manner in which the Major GPA is computed is to take the most recently earned grade in all courses designated by the major department/program. For Civil Engineering students, the Major GPA includes all AREN and CVEN courses.
4. The satisfactory completion of all Minimum Academic Preparation Standards (MAPS) deficiencies (<https://www.colorado.edu/engineering-advising/get-your-degree/degree-requirements/maps-minimum-academic-preparation-standards>)
5. Civil Engineering requires the successful completion of the Fundamentals of Engineering (FE) examination as an outcome measurement prior to graduation.

Students meet with their academic advisor to discuss progress towards degree requirements, and then apply for graduation via the Registrar's Office online system (https://www.colorado.edu/registrar/students/graduation#apply_for_graduation-677) Academic advisors review these students' academic records after final grades post and certify whether or not the student has met all degree requirements.

G. Transcripts of Recent Graduates

The program will provide transcripts from some of the most recent graduates. **The team chair will specify which transcripts to provide.**

CRITERION 2. PROGRAM EDUCATIONAL OBJECTIVES

A. Mission Statement

University of Colorado Boulder Mission

The Mission of CU is: *To shape tomorrow's leaders, be the top University for innovation, and to positively impact humanity.* It is published on the University website:

<https://www.colorado.edu/academicaffairs/homepage/mission-vision-values>

This mission is aligned with the Statutory Mission of the Boulder Campus described as:

CU Boulder's vision is grounded in its statutory mission as a national public research university. In Colorado statute, the university is defined as the "comprehensive graduate research university with selective admissions standards . . . offer(ing) a comprehensive array of undergraduate, master and doctoral degree programs" of what is now designated the University of Colorado System. This is published on the University website:

<https://www.colorado.edu/about/mission>

The University of Colorado strives to be a leader in addressing the humanitarian, social, and technological challenges of the twenty-first century. CU Boulder's identity is defined by respect for diversity and inclusivity.

College of Engineering and Applied Science Mission

The college's mission is to generate new knowledge in engineering and related fields, and to equip students from diverse backgrounds to become leaders and citizens responsible for the betterment of individuals and society. Our vision is to be a recognized world leader for excellence and innovation in engineering research and education, with an emphasis on inclusive excellence, active learning and global society.

<https://www.colorado.edu/engineering/mission-vision>

Dean Keith Molenaar is leading Strategic Visioning and Planning throughout 2023-24. For more information about that process, visit <https://www.colorado.edu/engineering-facultystaff/2022-23-strategic-planning>.

The Department of Civil, Environmental, and Architectural Engineering's mission is to educate undergraduate and graduate students to become leaders in the professional practice of engineering, contributing to technological advances that benefit humankind while enhancing the earth's physical and biological resources.

B. Program Educational Objectives

The program educational objectives (PEOs) for the Bachelor of Science degree in civil engineering are that within five years:

1. Graduates will be successfully employed in engineering, science, or technology careers.
2. Graduates will be assuming management or leadership roles.
3. Graduates will engage in continual learning by pursuing advanced degrees or additional educational opportunities through coursework, professional conferences and training, and/or participation in professional societies.
4. Graduates will pursue professional registration or other appropriate certifications.
5. Graduates will be engaged in activities that provide benefit to communities.

These objectives are published on the departmental website:

<https://www.colorado.edu/ceae/about/undergraduate-degrees/civil-engineering-educational-objectives>

The objectives are also published in the University of Colorado catalog:

<https://catalog.colorado.edu/undergraduate/colleges-schools/engineering-applied-science/programs-study/civil-environmental-architectural-engineering/civil-engineering-bachelor-science-bscv/#!text>

C. Consistency of the Program Educational Objectives with the Mission of the Institution

The overall themes in these institutional mission statements include the education of professionals who exhibit technological knowledge, leadership, and responsible citizenship; these are also reflected strongly in the Program Educational Objectives (PEOs) of the Civil Engineering program. The University of Colorado Boulder mission is mapped to the Program Education Objectives in Table 2.1:

Table 2.1. Mapping of Program Educational Objectives (PEOs) to Institutional Mission

Program Educational Objectives	Mission Statement 1: Shaping Leaders	Mission Statement 2: Innovation	Mission Statement 3: Positively Impact Humanity
1. Successful Employment	X		X
2. Leadership Roles	X	X	
3. Continual Learning		X	
4. Professional registration	X		X
5. Community Benefit			X

D. Program Constituencies

The primary constituents of the CVEN program are the students and alumni of the program, and the employers of our graduates. The departmental faculty members are also a constituency. The CVEN students and alumni are served through the program objectives by having employable skills that will help them find and advance in rewarding careers, building from their foundational skills in civil engineering. The alumni are invited to provide feedback to the program objectives formally via the online alumni survey distributed each summer. Alumni about five and/or eight years after earning their Bachelor's degree are invited to participate in the alumni survey.

Employers of our graduates are served through the program objectives by having employees with competence and commitment to keeping their technical skills up-to-date.

Alumni and employers of our graduates are invited to serve on advisory boards (i.e., the Joint Evaluation Committees, JECs) through which they can review and provide additional input to the educational objectives.

The departmental faculty members can use the program objectives to guide their teaching and mentoring activities of civil engineering students moving through the program. The faculty have the ability to revise these objectives if they believe that they are no longer serving CVEN students, alumni, and the engineering profession.

E. Process for Review of the Program Educational Objectives

There are two primary mechanisms that the department uses to review and revise the program educational objectives. First, the annual Joint Evaluation Committee (JEC) process affords faculty, students, and industry representatives the opportunity to review the educational objectives and give associated feedback on a yearly basis. The JEC meetings are held in May each year. Each JEC is comprised of program constituencies: practicing, professional engineers who are employers of our graduates and/or program alumni; one or more current students; and departmental faculty representatives.

All constituents also have informal but important input through ongoing contact with the program faculty. Potential changes to the program educational are discussed and approved by the civil engineering faculty every two years with a vote in September at a regularly scheduled department meeting. The discussion process is often facilitated via the departmental ABET coordinator and curriculum committee, which has representatives from the major faculty groups in the department. The potential changes are also discussed by the faculty at large and must be approved by a majority vote.

CRITERION 3. STUDENT OUTCOMES

A. Student Outcomes

The outcomes that students are expected to have attained upon graduation with a bachelor of science degree in civil engineering are listed below.

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. an ability to communicate effectively with a range of audiences.
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

These student outcomes are published on the departmental website:

http://www.colorado.edu/ceae/about/undergraduate-degrees/educational-objectives-outcomes?qt-quicktab_educational_outcomes=1#qt-quicktab_educational_outcomes

The student outcome are also published in the University of Colorado catalog:

<http://catalog.colorado.edu/undergraduate/colleges-schools/engineering-applied-science/programs-study/civil-environmental-architectural-engineering/civil-engineering-bachelor-science-bs/>

B. Relationship of Student Outcomes to Program Educational Objectives

The civil engineering program objectives map to the 7 student outcomes of our program, as shown below where an “x” indicates that the accomplishment of the related outcome is an important ingredient for accomplishing the objective. Table 3.1 illustrates that all five objectives are linked to two or more outcomes. Philosophically, consistency between the civil

engineering PEOs and the student outcomes (SOs) for engineering students is highly desirable for ensuring the professional success of our graduates.

Table 3.1. Mapping of Student Outcomes to the Program Educational Objectives

Program Educational Objectives	Student Outcomes						
	1	2	3	4	5	6	7
1. Graduates will be successfully employed in engineering, science, or technology careers.	x	x	x	x	x	x	x
2. Graduates will be assuming management or leadership roles.			x		x		x
3. Graduates will engage in continual learning by pursuing advanced degrees or additional educational opportunities through coursework, professional conferences and training, and/or participation in professional societies.				x			x
4. Graduates will pursue professional registration or other appropriate certifications.				x			x
5. Graduates will be engaged in activities that provide benefit to communities.	x	x	x	x	x	x	x

CRITERION 4. CONTINUOUS IMPROVEMENT

A. Student Outcomes

Outcomes Assessment Methods Summary

Table 4.1 provides a summary of the multiple direct and indirect methods that are used to assess achievement of each of the student outcomes. Not all methods are used for all outcomes. Each of the assessment methods is described in more detail in the paragraphs below. For some of the assessment results, data from the 2022-2023 academic year is still being compiled and analyzed. This data will be made available upon request. Assessment results are separated by major where possible.

The FE exam is the national NCEES Fundamentals of Engineering exam. It is a direct evaluation method that is used to assess 4 of the 7 student outcomes. All CU CVEN students are required to take the exam before they graduate; they typically take the exam one of their last two semesters. Data are provided from the NCEES summarizing the performance of our students twice per year (approximately January and July). The FE exam topics have been mapped to our student outcomes. Outcomes are flagged as a concern if CU students have a ratio score on the topic of interest relative to national CVEN students at 0.92 or lower. Data highlights including the overall pass rate and any weaknesses identified are presented to the CEAE faculty at an at-large meeting once per semester. Any problems are also discussed by the curriculum committee and the Joint Evaluation Committee which includes industry advisors.

The capstone design course offers an opportunity to evaluate the cumulative knowledge of the students with respect to many of the outcomes. An assessment rubric has been consistently employed in the capstone senior design course across the cycle to directly assess several of the outcomes based on the team design reports and oral presentations. The rubric developed was based on other published rubrics, and produces scores of 1 to 4 on various items (poor, needs improvement, adequate, and superior). Our target is that 80% or more of the team reports and/or individual assignments should score at an adequate or better level. Multiple faculty (generally four) assess the team project deliverables, while graduate students, serving as teaching assistants (TAs), rate the individual homework assignments. The rubric is also used in other required classes that have been mapped to specific outcomes and examples will be presented below with the evidence for each student outcome.

Within specific courses, various assignments (or questions on assignments), projects, lab write-ups, or exams are used as embedded indicators to directly measure student learning of some outcomes. Frequently, the normal grades on a particular assignment or question on an assignment are converted by the instructor to a rubric with a four-point scale, where: superior = 90% or more, adequate = 80%-90%, needs improvement = 70-80%, and poor = below 70%. The target is for 80% or more of our students to be rated adequate or above on each embedded indicator. A mapping of assessments to each outcome is presented in Table 4.1.

Table 4.1. Student Outcomes Assessment Methods: Summary (N/A = Not Applicable)

CU AREN Student Outcomes ABET 1-7.	Direct Assessment			Indirect Assessment	
	FE exam	Capstone Design course	Other Direct Assessment	Student FCQ ratings # Quest.	Senior survey # Quest.
1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	5 Topics	N/A	CVEN 3525, Structural Analysis; CVEN 3246, Intro to Construction; and CVEN 3227, Probability, Statistics, and Decision	1	1
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare as well as global, cultural, social, environmental, and economic factors	N/A	Final report	CVEN 4555 Reinforced Concrete Design	2	2
3. an ability to communicate effectively with a range of audiences	N/A	Final report & Presentation	CVEN 3161, Mechanics of Materials 1 CVEN 3718,	2	2
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts	Ethics & Professional Practice	N/A	CVEN 3414, Fundamentals of Environmental Engineering	1	1
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	N/A	course rubrics	CVEN 3708, Geotechnical Engineering	1	1
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	Statistics	N/A	CVEN 3161, Mechanics of Materials 1	2	2
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies	FE exam Pass rate	Reflective Essay	N/A	1	1

Two indirect assessment methods are also used to evaluate each of the 7 student outcomes. First, at the end of each semester, CU students are asked to evaluate the extent to which each of the CVEN undergraduate courses contribute to their achievement of the student learning

outcomes. These are questions that have been added to the university-wide Faculty Course Questionnaires (FCQs) that are administered by the campus. We expect that student ratings on a 1-5 scale should be at 4/5 or 80% or higher on targeted courses. These data for relevant courses are presented to the JECs. Data from selected courses targeted for each outcome are presented for each outcome in the following sections. Each academic year, the data from required courses are compiled in a spreadsheet to ensure that our targets are being met. In addition, the student evaluation data are compared to faculty ratings of how their courses contribute to the learning outcomes.

The second indirect assessment method used to evaluate each of the 7 student outcomes is the senior survey. The senior survey is administered by the College of Engineering & Applied Science three times per year. Students graduating in spring, summer and December are emailed invitations to participate in the survey, which is administered via the online package Qualtrics. Response rates are typically very high (over 90%) for CVEN students. In one section of the survey, students rate their achievement of all the 7 student outcomes, using a scale of 1 to 5. Achievement should be rated on average at 3.5/5 or 70% or higher to be satisfactory. The college provides the data for an academic year into a single report. The senior survey data are presented to the JECs for evaluation. They are also examined and summarized in an annual report written by the Assessment Coordinator and reviewed by the Department Chair.

The data for each outcome will be presented in detail in the following sections.

Outcome 1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

Outcome 1: FE exam

Direct assessment of this outcome is largely conducted by student performance on the NCEES Fundamentals of Engineering (FE) exam. We have decided to rely on five topics to evaluate this outcome: math, statics, dynamics, fluids, and mechanics of materials. Ratio scores are reported, representing the ratio of the average percentage of questions on a topic that CU CVEN students answer correctly divided by the average percentage of questions on a topic that CVEN students nationally answer correctly. The goal is to equal or exceed a ratio score of 0.92. We successfully met this goal for all topics. Overall, no deficiency is evident.

Table 4.2. FE exam results for Outcome 1.

Academic Year/Term:	2018-2019	2019-2020	2020-2021	2021-2022
<i>n</i>	30	14	33	37
FE Exam Topic	Ratio Scores of CU performance			
Math	1.10	1.12	1.01	1.07
Statics	.94	1.03	1.00	.98
Dynamics	.99	1.12	1.01	.92
Fluids	1.00	1.02	1.00	.97
Mechanics Materials	1.01	1.14	1.00	.97

Outcome 1: Course rubrics

This outcome was assessed directly by instructors in CVEN 3525, CVEN 3246, and CVEN 3227 through a course problem set. A rubric was developed to assess homework assignments and can be viewed below in Figure 4.1. The target across the year is 80% of students will be adequate or above. Data was collected in 2019-2020 with 87% of students above the cutoff, 2020-21 with 89% of students above the cutoff, and 2021-2022 with 85% of students above the cutoff. Across courses targets were met.

Poor	Needs Improvement	Adequate	Superior
1	2	3	4
Poor identification of the given engineering problem, making unnecessary or overly simplified assumptions. Solution is severely flawed, does not address required tasks.	Some tasks are missing/flawed, have difficulties in resorting to the correct tools or use them properly to solve the problem.	Can identify correct approach to address problem. Solution represents a basic level of understanding for all tasks.	High level ability to identify problem. Design and approach are largely flawless. Solution represents a high-level of understanding.

Figure 4.1. Rubric for assessment of Outcome 1, Identification of Problem

Outcome 1: Student Ratings on Course FCQs

The FCQ for outcome 1 was mapped to CVEN required courses. Ratings are presented as a percent in Table 4.3 below with a 75% cutoff.

Table 4.3. FCQ ratings of Outcome 1.

Academic Year	Required Courses
2018-2019	79%
2019-2020	79%
2020-2021	85%
2021-2022	87%

Ratings of Outcome 1 on the FCQ were above the cutoff across all available data, indicating that we are meeting this outcome.

Outcome 1: Senior Survey

On the survey distributed to all graduating senior students, students are asked to rate their personal achievement on the outcome “ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.” using a Likert-scale from 1 to 5. These achievement ratings all exceed the target of 70% (3.50/5) and indicate no weaknesses for this outcome (Table 4.4).

Table 4.4. Senior survey ratings of Outcome 1

Senior Survey	Year	2018	2019	2020	2021	2022
		-19	-20	-21	-22	-23
<i>Rating</i>		80%	86%	83%	80%	NA

Summary: All of the direct and indirect assessment measures met our targets in each academic year. Therefore, this outcome has been sufficiently achieved.

Outcome 2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.

Outcome 2. Senior Design Rubric

Capstone Design Instructors developed the following rubric (Figure 4.2) to rate both the ability to apply design and considerations of design within context.

Sub-topics					
		Poor	Needs Improvement	Adequate	Superior
		1	2	3	4
1	Ability to identify and state the engineering problem and constraints	Client(s) needs not assessed; problem poorly defined; key constraints lacking	Client(s) needs not thoroughly assessed; problem not well defined; some significant constraints not addressed	Client(s) needs thoroughly assessed, problem well-defined, all critical constraints addressed	Client(s) needs thoroughly assessed, problem well-defined; all constraints stated; unexpected insight into client's needs
2	Ability to compare and make selection between design alternatives with consideration for life-cycle costs, sustainability, public health, safety, social	No explicit evaluation of alternatives in a quantitative and/or qualitative fashion	Alternatives identified, but limited evaluation of impact of each	Distinct, practical alternatives identified with consideration for life-cycle costs, sustainability, public health, safety, social and environmental	In addition to typical/practical alternatives, team pursues unique and innovative options for clients' consideration

	and environmental factors			factors (as applicable)	
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Figure 4.2. Capstone design rubric for Outcome 2.

Results for the application of design and considerations of the design context were rated from the report. Table 4.5 below displays the results across years. It was expected that 80% of students would be rated at adequate or above on the rubric. Ratings are displayed below in Table 4.5.

Table 4.5. Capstone design rubric ratings of Outcome 2.

Academic Year	Design Application: Final Report	Considerations of Context: Final Report
2019-2020	95%	93%
2020-2021	92%	91%
2021-2022	95%	91%

The design data indicate sufficient fulfillment of this outcome, since >80% of the students possessed an adequate ability to design a system or component and consider the context of the design.

Outcome 2: Course Rubrics, CVEN 4555

Course rubrics to measure skills with design applications and considerations of the design context were developed for CVEN 4555. It was expected that 75% of students would be rated above the cutoff. Results were above expectations and overall expectations were met (Table 4.6).

Table 4.6. Capstone design rubric ratings of Outcome 2.

Academic Year	Design Application	Considerations of Design Context
2019-2020	98%	94%
2020-2021	92%	91%
2021-2022	86%	92%

Outcome 2. Student Ratings on Course FCQs

Students were asked two questions on the FCQs for Outcome 2. The first asked about their ability to apply engineering design to produce solutions and the second asked about their ability to design with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. Ratings were made on a 6-point scale in 18-19 and a 5-point scale afterwards. Results are presented below in Table 4.7 as percentages to allow for comparisons and expected to be above 75%. Results are unavailable for 2020 due to the global pandemic.

Table 4.7. Capstone design FCQ ratings of Outcome 2.

Academic Year	Design Application: FCQ	Considerations of Context: FCQ
2018-2019	88%	85%
2019-2020	N/A	N/A
2020-2021	95%	92%
2021-2022	92%	85%

Ratings on FCQs were above the cutoffs for senior design for Outcome 2 indicating that we are meeting targets.

Outcome 2. Senior Survey

The senior survey included two questions related to design ability; results are summarized in Table 4.8 below. The first question asked about their ability to apply engineering design to produce solutions and the second asked about their ability to design with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. Ratings were made on a 5-point scale and translated into percentages for comparison with other assessment results. Expectations were that ratings would average 3.5/5 (70%) or higher.

Table 4.8. Senior survey ratings of Outcome 2

Academic Year	Design Application: Senior Survey	Considerations of Context: Senior Survey
2018-2019	82%	79%
2019-2020	82%	79%
2020-2021	76%	76%
2021-2022	83%	79%

Overall, ratings on the senior survey are meeting goals for Outcome 2.

Summary: The direct assessment data from capstone design is supported by the indirect assessment data and demonstrates that the students have adequate abilities to design when they graduate.

Outcome 3. an ability to communicate effectively with a range of audiences.

Outcome 3. Senior Design Rubric

In the senior design course, the final team oral presentations and written reports were graded by instructors and industry mentors using a rubric, with two elements to embody oral presentation and communication ability with clients. Each semester four graders rate each team using a scale of 1 to 4 with expectations that 80% of student would be rated above a 3, Adequate. Results are shown in Table 4.9. Over 80% of the teams were adequate or higher in all four categories, indicating adequate communication skills among the CVEN students.

Table 4.9. Capstone design rubric ratings of Outcome 3

Academic Year	Oral Communication: Final presentation	Written Communication: Final Report
2019-2020	85%	90%
2020-2021	95%	93%
2021-2022	98%	93%

Outcome 2: Course Rubrics, CVEN 3161 and CVEN 3718

Course rubrics to measure skills with design applications and considerations of the design context were developed for CVEN 3161 and 3718. It was expected that 75% of students would be rated above the cutoff. Results were above expectations and overall expectations were met (Table 4.10).

Table 4.10. Capstone design rubric ratings of Outcome 3.

Academic Year	Oral Communication	Written Communication
2019-2020	95%	93%
2020-2021	93%	94%
2021-2022	85%	100%

Outcome 3. Student Ratings on Course FCQs

The ability to communicate effectively via oral presentations and written reports with a range of audience is most consistently included in the senior design course. Students were asked two questions on the FCQs for Outcome 3. The first asked about their ability with oral communication skills and the second asked about their ability with written communication skills. Ratings were made on a 6-point scale in 18-19 and a 5-point scale afterwards. Results are presented below in Table 4.11 as percentages to allow for comparisons and expected to be above 75%. Results are unavailable for 2020 due to the global pandemic.

Table 4.11. Capstone design FCQ ratings of Outcome 3.

Academic Year	Oral Communication: FCQ	Written Communication: FCQ
2018-2019	81%	86%
2019-2020	N/A	N/A
2020-2021	93%	93%
2021-2022	83%	84%

Ratings on FCQs were above the cutoffs for senior design for Outcome 3 indicating that we are meeting targets.

Outcome 3. Senior Survey

The senior survey included two questions related to communication ability; results are summarized in Table 4.12 below. The first question asked about their oral communication ability and the second asked about their written communication ability. Ratings were made on a 5-point scale with a 3.75/5 or 70% target.

Table 4.12. Senior survey ratings of Outcome 3

Academic Year	Oral Communication: Senior Survey	Written Communication: Senior Survey
2018-2019	72%	66%
2019-2020	70%	76%
2020-2021	73%	73%
2021-2022	74%	73%

Overall, ratings on the senior survey were above the 70% cutoff for most years and did meet goals for outcome 3 with the exception of 18-19 for written communication. Results should be monitored on this assessment in the future.

Summary: The strongest measure that students have sufficient ability in communication skills is based on direct evaluation via the co-instructors and industry mentors of the senior design course. The students make a formal oral presentations and develop a written design report in the course and the data shows strong evidence of abilities by most students. The direct assessment measurement supports sufficient attainment of this outcome. Indirect assessment flagged communication skills on senior surveys for one year so written communication should be monitored in future senior survey assessments.

Outcome 4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.

Outcome 4. FE Exam

There are questions on the FE exam that relate to professional and ethical responsibility, which we use as a direct assessment for ABET. The goal is for scores to be equal or over a ratio score of .92. Overall, we consider that we met our goal with the exception of 21-22. We will continue to monitor student knowledge of professional and ethical issues on the next FE exam (Table 4.13).

Table 4.13. FE exam results for Outcome 4

FE Topic	Year	17-18	18-19	19-20	20-21	21-22
	<i>n CU students</i>	44	30	14	33	37
Profession & ethics	Ratio score	1.12	.97	1.10	.97	.88
	% Difference from national average	+.12	0	-4	-.3	-.12

Outcome 4. Direct Assessment: Student Performance on Quiz/Homework

CVEN 3414 includes a homework assignment focused on sustainability. Homework assignments were rated by the course instructor on the rubric below (Figure 4.3).

Poor	Needs Improvement	Adequate	Superior
under 70	70 to 79	80 to 92	93+

Student demonstrated poor effort in researching topic. topic not applicable to environmental issues at hand. An obvious lack of clarity and creativity.	There was some effort to research the topic. Presentation topic demonstrates some understanding to environmental issues at hand.	The research effort for this presentation was adequate. Objectives were clearly followed and topic relevant to environmental engineering issues at hand.	Presentation excellent. Research effort excellent. The presentation topic was unique, was in line with environmental concerns and displayed outstanding creativity.
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Figure 4.3. Rubric for assessment of Outcome 4 in CVEN 3414.

It was expected that 80% of student assignments would be rated at or above an adequate rating. Results are presented in Table 4.14 from 2019 when ABET 1-7 outcomes were adopted. Results were above the target for each year indicating the goals were met for this assessment.

Table 4.14. Homework performance on Outcome 4

Academic Year	Outcome 4: Homework
2019-2020	91%
2020-2021	85%
2021-2022	92%

Outcome 4. Student Ratings on Course FCQs

The ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts is rated on the FCQs for Capstone Design. Ratings were made on a 6-point scale in 18-19 and a 5-point scale afterwards. Results are presented below in Table 4.15 as percentages to allow for comparisons and expected to be above 75%. Results are unavailable for 2020 due to the global pandemic.

Table 4.15. Capstone design FCQ ratings of Senior Design for Outcome 4.

Academic Year	Outcome 4: Ethics FCQ
2018-2019	83%
2019-2020	N/A, pandemic

2020-2021	92%
2021-2022	83%

Ratings on FCQs were above the cutoffs for senior design for outcome 4 indicating that we are meeting targets.

Outcome 4. Senior Survey

The senior survey included one question related to ethics ability; results are summarized in Table 4.16 below. The question asked about an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.. Ratings were made on a 5-point scale with a 3.50/5 or 70% target.

Table 4.16. Senior survey ratings of Outcome 4.

Academic Year	Ethics: Senior Survey
2018-2019	82%
2019-2020	80%
2020-2021	76%
2021-2022	78%

Overall, ratings on the senior survey are meeting goals for Outcome 4.

Summary: Both the direct and indirect data are uniformly supportive that civil engineering students from our program have sufficient knowledge of ethical and professional issues.

Outcome 5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.

Outcome 5. Senior Design Rubric

In the senior design course, the final team written reports were assessed by instructors and industry mentors using a rubric. Raters evaluate the extent to which teams can produce a final report for clients that summarizes the overall design solution, synthesizing all disciplines as an indication of their ability to function effectively as a team and produce a professional product for the client(s). Each semester four graders rate each team using a scale of 1 to 4 with expectations that 80% of student would be rated above a 3, Adequate. Results are shown in Table 4.17.

Table 4.17. Capstone design rubric ratings of Outcome 5.

Academic Year	Outcome 5: Final design report
2019-2020	91%
2020-2021	93%
2021-2022	93%

Over 80% of the teams were adequate or higher, indicating adequate communication skills among the CVEN students.

Outcome 5. Student Ratings on Course FCQs

An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives is rated on the FCQs for Capstone Design. Ratings were made on a 6-point scale in 18-19 and a 5-point scale afterwards. Results are presented below in Table 4.18 as percentages to allow for comparisons and expected to be above 75%. Results are unavailable for 2020 due to the global pandemic.

Table 4.18. Capstone design FCQ ratings of Senior Design for Outcome 5.

Academic Year	Outcome 5: Teamwork FCQ
2018-2019	85%
2019-2020	N/A, pandemic
2020-2021	95%
2021-2022	92%

Ratings on FCQs were above the cutoffs for senior design for Outcome 5, indicating that we are meeting targets.

Outcome 5. Direct Assessment, Course Rubric

A course rubric (Figure 4.4) was developed for CVEN 3708 to assess teamwork skills. The outcome of the assignment is shown in Table 4.19.

Sub-topics	Poor	Needs Improvement	Adequate	Superior
	under 62	62 to 79	80 to 88	88+

Ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	Team member is clearly working individually without much communication or collaboration. Team member not able to manage project tasks	Team member had difficulties in working with the team. Lab report show inconsistent quality in different sections. Project management needs improvement	The team member demonstrates a basic level of collaboration and communication. Lab report shows consistent effort from team member. Project management skills adequate	Clear leadership and teamwork demonstrated in the lab session. Team member worked to tackle difficult tasks or resolve conflicts. Lab report is well integrated and well presented. Project is well managed by team member
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Figure 4.4. Course Rubric for Outcome 5 in CVEN 3708.

Table 4.19 Course Rubric Ratings on Outcome 5 for CVEN 3708.

Academic Year	Outcome 5: CVEN 3708 Rubric
2019-2020	92%
2020-2021	96%
2021-2022	93%

Outcome 5. Senior Survey

The senior survey included one question related to Outcome 5 ability; results are summarized in Table 4.20 below. The question asked about their ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives. Ratings were made on a 5-point scale with a 3.50/5 or 70% target.

Table 4.20. Senior survey ratings of Outcome 5.

Academic Year	Outcome 5: Senior Survey
2018-2019	83%
2019-2020	90%
2020-2021	81%
2021-2022	99%

Overall, ratings on the senior survey are meeting goals for Outcome 5.

Summary: The direct and indirect assessments provide sufficient evidence that our students reliably graduate with the ability to function on multidisciplinary teams.

Outcome 6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

Outcome 6. FE exam.

Direct assessment of this outcome is largely conducted by student performance on the NCEES Fundamentals of Engineering (FE) exam. We have decided to rely on the Probability and Statistics assessment. Ratio scores are reported in Table 4.21, representing the ratio of the average percentage of questions on a topic that CU AREN students answer correctly divided by the average percentage of questions on a topic that AREN students nationally answer correctly. The goal is to equal or exceed a ratio score of 0.92. We successfully met this topic for each year measured indicating targets are being met.

Table 4.21. FE exam Probability and Statistics ratio scores.

Academic Year	FE Exam Results
2018-2019	1.02
2019-2020	.96
2020-2021	1.01
2021-2022	1.101

Outcome 6. Course Direct Assessments

CVEN 3161, Mechanics of Materials, includes a homework assignment with a written report focused on Outcome 6. CVEN student reports were rated by the course instructor on the rubrics below. Rubrics were created for experimentation (Figure 4.5) and data analysis and judgement (Figure 4.6) below.

Ability to develop and conduct appropriate experimentation	Unable to follow the lab procedure and failed to acquire expected data from the experiments.	Can follow the lab procedure and finish the tasks. Poor data management and interpretation, leading to incorrect	Correctly follow the lab procedure, properly record and process the data, and deliver an adequate lab report. Can derive proper conclusions from the data.	Demonstrates strong experimentation skills in conducting the lab, checks the correctness of the data as the lab proceeds. Flawless post-processing of the data, leading to
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		conclusions from the experiment.		correct conclusions and can comment on potential source of errors
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Unable to follow the lab procedure and failed to acquire expected data from the experiments.	Can follow the lab procedure and finish the tasks. Poor data management and interpretation, leading to incorrect conclusions from the experiment.	Correctly follow the lab procedure, properly record and process the data, and deliver an adequate lab report. Can derive proper conclusions from the data.	Demonstrates strong experimentation skills in conducting the lab, checks the correctness of the data as the lab proceeds. Flawless post-processing of the data, leading to correct conclusions and can comment on potential source of errors
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Figure 4.5. Rubric for assessment of homework assignment mapped to Outcome 6, Experimentation.

Ability to acquire and apply new knowledge as needed, to analyze and interpret data, and use engineering judgment to draw conclusions	Very incomplete or incorrect interpretation of trends and comparison of data indicating a lack of understanding of results. Conclusions missing or missing the important points.	Some of the results have been correctly interpreted and discussed; partial but incomplete understanding of results is still evident. Conclusions regarding major points are drawn, but many are misstated, indicating a lack of understanding.	Almost all of the results have been correctly interpreted and discussed, only minor improvements are needed. All important conclusions have been drawn, could be better stated.	All important trends and data comparisons have been interpreted correctly and discussed (with sources), understanding of results is conveyed. All important conclusions have been clearly made, student shows good understanding.
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Ability to acquire and apply new knowledge as needed, to analyze and interpret data, and use engineering judgment to draw conclusions	Very incomplete or incorrect interpretation of trends and comparison of data indicating a lack of understanding of results. Conclusions missing or missing the important points.	Some of the results have been correctly interpreted and discussed; partial but incomplete understanding of results is still evident. Conclusions regarding major points are drawn, but many are misstated, indicating a lack of understanding.	Almost all of the results have been correctly interpreted and discussed, only minor improvements are needed. All important conclusions have been drawn, could be better stated.	All important trends and data comparisons have been interpreted correctly and discussed (with sources), understanding of results is conveyed. All important conclusions have been clearly made, student shows good understanding.
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Figure 4.6. Rubric for assessment of homework assignment mapped to Outcome 6, Data Analysis and Judgement.

Expected results were that 80% of students would be rated in the top (right of the figure) two categories on the rubric. Results revealed students were rated above the cutoff for each year and that targets were met for this assessment (Table 4.22).

Table 4.22. Course Rubrics assessment for CVEN 3161, Mechanics of Materials

Academic Year	Outcome 6: Experimentation Course Rubric	Outcome 6: Data Analysis/Judgement Course Rubric
2018-2019	91%	92%
2019-2020	91%	93%
2020-2021	84%	77%
2021-2022	86%	81%

Outcome 6. Student Course FCQs

An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions is rated on the FCQs for CVEN 3323, Hydraulic Engineering. Two questions were asked for this outcome 1) An ability to develop and conduct experimentation and 2) analyze and interpret data, and use engineering judgment to draw conclusions. Ratings were made on a 6 point scale in 18-19 and a 5 point scale afterwards. Results are presented below in Table 4.23 as percentages to allow for comparisons and expected to be at or above 75%. Results are unavailable for 2020 due to the global pandemic.

Table 4.23. Capstone design FCQ ratings of CVEN 3323 for Outcome 6.

Academic Year	Outcome 6: Experimentation FCQ	Outcome 6: Data Analysis/Judgment FCQ
2018-2019	81%	85%
2019-2020	75%	80%
2020-2021	70%	83%
2021-2022	86%	93%

Ratings on FCQs were above the cutoffs for CVEN 3323, Hydraulic Engineering for outcome 6, except for 2020-2021 which may have been impacted by a mostly remote year. Overall, we did meet targets for this assessment of Outcome 6.

Outcome 6. Senior Survey

The senior survey included one question related to Outcome 6 ability; results are summarized in Table 4.24 below. The question asked about their ability to develop and conduct

appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions. Ratings were made on a 5-point scale with a 3.50/5 or 70% target.

Table 4.24. Senior survey ratings of Outcome 6.

Academic Year	Outcome 6: Experimentation Senior Survey	Outcome 6: Data Analysis/Judgment Senior Survey
2018-2019	69%	82%
2019-2020	71%	83%
2020-2021	75%	75%
2021-2022	70%	83%

Overall, ratings on the senior survey were above targets for outcome 6 on data analysis but below targets on experimentation for 1 out of 4 years assessed. We are mostly meeting the outcome on this assessment and should monitor experimentation results on this assessment moving forward.

<p>Summary: Overall, direct and indirect assessments are meeting targets for this outcome with the exception of experimentation ratings on the senior survey.</p>
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Outcome 7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Outcome 7. FE Exam

We believe that students' overall performance on the FE exam is indicative of their motivation, ability, and willingness to acquire and apply new knowledge as needed, using appropriate learning strategies, given that this is a first step on the path to become a licensed PE, and PE licensure requires additional learning. Pass rates for CVEN students on this exam were compared with national averages with pass rates no more than 5% below the national average. Results are presented below in Table 4.25. Across years, CU CVEN students performed above national peers in three academic years. Overall, we are meeting targets on this assessment.

Table 4.25. CVEN student pass rates on FE exam.

Year	18-19	19-20	20-21	21-22
<i>n CU students</i>	54	52	75	60
CU student pass rate	71%	92%	69%	60%
Exam % difference from national average	+3.4	+19	-1.2	-4.5

Outcome 7. Capstone Design Rubric

Outcome 7 is measured by the Capstone design rubric on the final team design report rated by instructor and industry advisors. Results are expected to find 80% of students rated as adequate or above on the rubric. We were above targets each year indicating that the outcome targets are met on this assessment (Table 4.26).

Table 4.26. Capstone Design ratings of Outcome 7.

Academic Year	Outcome 7: Capstone Rubric
2019-2020	90%
2020-2021	93%
2021-2022	95%

Outcome 7. Student Ratings on Course FCQs

The ability to acquire and apply new knowledge as needed, using appropriate learning strategies was mapped to Capstone Design. Ratings were made on a 6-point scale in 18-19 and a 5-point scale afterwards. Results are presented below in Table 4.27 as percentages to allow for comparisons and expected to be above 75%. Results were above targets on assessment indicating we are meeting objectives for Outcome 7 on this assessment.

Table 4.27. FCQ ratings of Outcome 7.

Academic Year	Outcome 7: Capstone Design
2018-2019	86%
2019-2020	N/A: Pandemic
2020-2021	94%
2021-2022	82%

Outcome 7. Senior Survey

The senior survey included one question related to Outcome 7 ability; results are summarized in Table 4.28 below. The question asked about their ability to acquire and apply new knowledge as needed, using appropriate learning strategies. Ratings were made on a 5-point scale with a 3.50/5 or 70% target.

Table 4.28. Senior survey ratings of Outcome 7.

Academic Year	Outcome 7: Senior Survey
2018-2019	83%
2019-2020	84%
2020-2021	79%
2021-2022	82%

Overall, ratings on the senior survey were above targets for outcome 7. We met targets for this assessment.

Summary: Direct and indirect assessment of Outcome 7 indicated students have developed sufficient skills that are above targets on the assessments.

Overall Summary Across Outcomes Assessment

Across outcomes, assessments are above targets on 5 of the 7 outcomes. For outcome 3, assessments were below target on written communications skills and for outcome 6, assessments were below target on experimentation indicating partial success on these outcomes, but also offering areas for improvement.

B. Continuous Improvement

Efforts to engage in continuous improvement of the program have been initiated in several areas. Concerns about outcome 3, communication skills and outcome 6, experimentation were reported in the department meeting and at the JEC. The following strategies were developed.

Strategies to Address Outcome 3, Improved Communications in Coursework – Probability and Statistics

Context: CVEN 3227, Probability, Statistics and Decision is a required course for juniors in civil engineering. It addresses concepts of probability theory, statistical analysis, machine learning and risk assessment, as applied to engineering problems in civil engineering. It is a logical place to improve communication, because civil engineers play a central role both in applying these skills, and also in communicating these to clients to improve design decisions. It is a large course (typically over 100 students), so it is also a good opportunity to practice public speaking.

New Course Content: A communication module has been added to the course. This communication module addresses written and oral communication, and types of communication that had been suggested as areas of focus during our JEC meetings.

The assignments include:

- a) Attending office hours and asking a question of the Professor or TA. The goal of this assignment was to encourage students to develop relationships with mentors.
- b) Writing an email to a client summarizing the results of calculations, and the implications for design and maintenance decisions. The goal of this assignment was to improve technical email communication.
- c) Writing an email to a client requesting information. This information then needed to be included in a problem set. Students were also assigned to review their email in Grammarly and address grammatical and tone suggestions as suggested by the tool. The goal of this assignment was to improve technical email communication.
- d) Leaving a voicemail for a client describing the solution to a problem. This voicemail could not be pre-recorded. The goal of this assignment was to improve technical oral communication.
- e) Listening to one of 2 podcasts (one on data visualization and the other on use of statistics in college admissions), and reflecting on the podcasts. The goal of this assignment was to observe other forms of communication about data and statistics, and encourage reflection on the role of technical “stewardship” in communicating such topics. .
- f) Making a 3 minute presentation on a topic of their choosing related to probability of statistics.
- g) (Optional) Writing a letter (email, hand written, long text message) or making a phone call to someone who has been isolated or experienced mental health struggles because of the COVID-19 pandemic.

Each assignment was assessed according to a rubric that evaluated both the form of the communication (salutations, grammar, slide format, level of formality) as well as the substance of the communication (were results correct and explained appropriately). The

presentation was graded on organization, clarity, visual materials, and technical content. The more time consuming assignments were weighted more heavily in the assessment.

Improving Outcome 6, Experimental Design Skills

CVEN 3161, "Mechanics of Materials," is taught as a lecture with an associated laboratory section, providing ample opportunity for the students to develop and conduct appropriate experiments both during the laboratory section and in class.

In terms of the laboratory sessions, we focused on having students write about how they would redesign each experiment in the class knowing that the experimental results do not align with published data, which they had to research in developing their lab reports. This would encourage them to consider experimental design issues (in addition to issues related to material imperfections and equipment calibration).

We also changed the text of the third laboratory experiment, which is the concrete cylinder compression test. The data from the experiments typically showed a great deal of variability, so we reworded that assignment to include detailed statistical analysis. Students now quantify the scatter, calculate the mean and standard deviation of the compressive test results (grouped by compressive strength of each concrete cylinder), and then discuss how they might handle variability in measured values in the mechanics design process. This was not discussed in class on purpose to encourage them to draw on their knowledge of statistics and the equations from class when developing improvements in their experimental design. Additionally, we ask students to interpret their results and recommendations for two audiences: (1) for a more general audience with varying levels of familiarity with the scientific tests performed, and (2) for a scientific audience. The students were graded based on how they might "redesign the experiment to improve consistency in results", and how they might improve their experimental design otherwise.

We considered larger changes to the laboratory experiments, but were unable to enact these changes due to restrictions and other changes that occurred during the COVID-19 pandemic.

In addition to laboratory experiments, we conducted in-class experiments that allowed individual students to draw conclusions and share their analysis with the entire group. During one experiment, students simulated a torsion test by twisting (1) tootsie rolls and (2) chalk, drawing the failure surfaces, and discussing why chalk had a 45-degree failure plain (while the tootsie roll did not). Students recorded their observations, shared with pairs, shared in larger groups, and then reported results to the whole class. During another experiment, students put pieces of spaghetti under compression to demonstrate Euler Buckling. Before we learned deeply about Euler Buckling, students were asked to write down their observations related to the mode of failure, and what properties (material and geometric properties) they could change to prevent the spaghetti from failing in this mode. Again, they shared results in pairs, larger groups, and with the whole class. Students correctly identified that they could increase the cross-sectional area, decrease the length, or change the material properties - which helped them to identify similar design improvements once they were analyzing structural columns. Students were graded based on their observations from these in-class experiments on their final exam with a multiple-choice question.

Undergraduate Student Pathways Committee

The Undergraduate Student Pathways Committee (pathways committee) was started in Fall 2019 as a mechanism for staff, faculty, and department leadership to collaborate and co-develop programs and activities that help shape the out-of-class student experience in the department. The pathways committee has since convened bi-weekly during fall and spring academic semesters, and it has a set membership each year as determined by the department chair. The committee members include representation from the academic advisors, architectural engineering faculty, and civil engineering faculty. The committee reports to the department Executive Committee periodically for feedback on initiatives and committee scope. The current committee goal and objective are as stated below.

In support of the CU Boulder mission and vision to shape leaders who address the humanitarian, social, and technological challenges of the twenty-first century, this committee's purpose is to *support activities that inspire students to participate* in this vision and to *help students develop their personal aspirations for contributing* to the greater good.

This committee will *develop CEAS* activities and *support* other related university and CEAS activities to:

1. Recruit students to apply to the Civil, Architectural, and Environmental Engineering degree programs
2. Welcome undergraduate students into the department degree programs;
3. Provide opportunities for students to understand and get excited about the range of how CEA engineers engage in and positively impact the world;
4. Provide opportunities for students to create CEAE community with peers, faculty, advisors, and mentors;
5. Actively support students in identifying pathways including:
 - (a) Undergraduate academic;
 - (b) Graduate academic;
 - (c) Career;
6. Recognize excellence and celebrate students upon graduation.

Specific, current committee activities that support the objectives include:

1. Developing and implementing a recruiting strategy that includes outreach to high school and admitted college students and their families via social media and high school visits.
2. Planning and hosting of an annual student welcome fair.
3. Planning and hosting of an industry panel of recent graduates.
4. Piloting a professional mentorship program.
5. Planning and hosting of a fall and spring career fair.
6. Nominating students for college and department awards in the fall and spring semesters.

Professional Mentorship Program

In academic year 2022-2023, the department kicked off a pilot professional mentorship program in partnership with the college and the CU Alumni Association. The program is hosted on the Forever Buffs Network (FBN) platform for CU alumni. While the program is

therefore restricted to alumni mentors, it is an approach that allows any undergraduate student to sign up for a mentor if they choose to do so.

Mentor/mentee matches are made through a mixed manual and automated approach based on what is known about the goals of the students, mentors, and information included in their FBN profiles. Matches are made in the fall semester and then mentorship pairs fill out a contract together that allows them to define and agree upon meeting time, modes, and topics. Training is provided for the mentors and mentees via the FBN platform.

The department collaborated with the college to set up an engineering subgroup on the FBN platform. All CEAE mentorship pairs are part of this group. They receive information in addition to that provided by the CU Alumni Association such as engineering-specific mentorship questions, and links to professional accomplishments and project case studies.

In the 2022-2023 academic year, the campus-wide mentorship program had 158 active mentorship relationships. The College of Engineering and Applied Science has 70 relationships, 39 of which include civil, environmental, or architectural engineering students. The pilot program ends in May of 2023 at which time feedback about the program will be collected from mentees and mentors. Adjustments will be made as needed to improve program efficacy prior to the 2023-2024 academic year.

Faculty Advising

Starting in the 2018-2019 academic year, the CEAE Department transitioned to a new model for academic advising and mentoring. Prior to this, the advising model was as follows: freshman and sophomore students were required to meet every semester with the staff advisor for their major. Juniors selected a faculty advisor in the fall of their junior year and were required to meet with their faculty advisor every semester until graduation. Faculty advisors conducted 20-minute individual meetings with each student over a designated two-week period each semester.

At our last ABET site visit in Fall 2017, students indicated that they wished they had more time to talk about careers with their faculty advisors, instead of just spending the time picking classes. In response to this feedback, the architectural engineering program piloted a new advising model in Spring 2020. Under this system, the staff advisor took over responsibility for advising all AREN students regarding their degree requirements and making sure they were enrolling in the correct classes every semester. Faculty advisors were renamed “faculty mentors” to align with other programs in the College and were asked to focus more on career-related discussions with students. This included career options, choice of technical electives, internships, graduate school, research opportunities, etc.

The pilot program received no negative feedback from students or faculty and was expanded to the civil engineering program in Spring 2020. Once the entire CEAE Department was following the same advising model, it made additional changes possible. Faculty now have the option to conduct their mentoring meetings via individual appointments, drop-ins, or group sessions based on their preferences. Some faculty have reported that group sessions

give the opportunity for more discussion among the students, and students have the option to request an individual meeting if they prefer.

CVEN Curriculum changes since 2016

The following changes were made in Fall 2017. These changes were approved by CEAE faculty in a faculty meeting on 2/3/2016.

- The computing course was changed from CHEN 1310 (3 credits) to CSCI 1320 (4 credits). This change was made because the topics and tools covered in the CSCI course (Matlab, C++) provide our students with better preparation for computing and programming logic than the topics and tools covered in the CHEN course (Excel, VBA, Matlab).
- CVEN 1317 Intro to Civil Engineering– changed from 2 credits to 1 credit; AREN and CVEN sections are proposed to be split. This change is made to accommodate the 4-credit computing class. It is also consistent with other Intro courses in the college.
- Engineering Drawing – changed from 1 credit to 3 credits, and a new CVEN drawing course was created. CVEN 1027 Engineering Drawing teaches Civil3D, AREN 1027 Engineering Drawing teaches Revit. Civil engineering students could take either one. The increase from 1 credit to 3 credits is made because students’ drawing skills were not necessarily meeting our expectations, the logistics of teaching a 1 credit course was challenging, and several Joint Evaluation Committee reviews recommended that students have more drawing. The creation of a second course (CVEN 1027) was recommended because the drawing needs of CVEN students may not necessarily be the same as the drawing needs of AREN students. AREN students use Revit, which is suitable for vertical drawing. However, for some CVEN sub-disciplines, horizontal drawing is a better skill.
- CVEN 2012 Geomatics – changed from 2 credits to 3 credits and moved from 2nd semester (spring) to 3rd semester (fall). The change from 2 credits to 3 credits is made to align with the AREN requirements. The change to the fall semester was made because the weather in the fall semester is much better.
- CVEN 3698 Engineering Geology or Basic Science Elective – changed from 3rd semester (fall) to 4th semester (spring). This change was made to accommodate moving Geomatics to the fall semester.
- Three S-H electives were moved to different semesters to balance out the credits each semester.

The following changes were made by the College of Engineering and Applied Science that were implemented in the CVEN curriculum in 2020:

- CHEN 1211 General Chemistry for Engineers (4 credits) and CHEM 1221 General Chemistry Lab for Engineers (1 credit) were replaced with CVEN 1201 General Chemistry for Engineers I (4 credits) and CHEM 1114 Lab in General Chemistry I (1 credit). This change was made to align the chemistry courses with the needs of the majors.

The following changes were made to the CVEN curriculum for Fall 2020. Approved by CEAE faculty on 2/19/2020.

- Remove the option of fulfilling the Engineering Geology requirement with another Basic Science Elective. Now CVEN 3698 Engineering Geology is required. This change was made because students need the content from Engineering Geology for geotechnical engineering. Also, the flexibility was intended to allow students to choose a science course that aligned with their intended career path; however, most students who took a different Basic Science elective chose a course to which they could apply AP Biology credit, which left them less prepared for geotechnical engineering (having not taken Engineering Geology) and no better prepared for their intended career path.
- Replace the computing course (CSCI 1320, 4 credits) with CSCI 1200 Intro to Computational Thinking (3 credits) and a new course CVEN 2107 Excel and Matlab Primer (1 credit). This change was made because CSCI 1320 is no longer offered. CSCI 1200 teaches python, so students learn structured programming. However, the students would no longer have formal training in Excel and Matlab, which are important tools for the CVEN curriculum. So a new 1-credit course on Excel and Matlab was added. CSCI 1200 is only offered in the Fall semester, so computing was moved to the first semester (CSCI 1320 was taken in the second semester). The Excel and Matlab primer should be taken after CSCI 1200 and closer to the time when the students would need to apply their Excel and Matlab skills, so CVEN 2107 is taken in the fourth semester.
- GEEN 1400 Engineering Projects was moved from the first semester to the second semester to accommodate the changes in the computing class.

CVEN Joint Evaluation Committee (JEC) Meeting Format Improvement: A Case Study in Support of Criterion 2.0 Program Objectives and 4.0 Continuous Improvement

Context: Through AY 2018-2019, the Department of Civil, Environmental, and Architectural Engineering (CEAE) underwent a periodic evaluation by a committee comprised of students, faculty, and industry professionals **known as the Joint Evaluation Committee (JEC)**. The evaluation occurred every three years. The format of the meeting included a day-long agenda, composed of presentations by faculty to the committee, a review of program objectives, a review of the curriculum, a review of student work, research presentations by the faculty, and an in-depth, conversation regarding suggested changes or additions to the curriculum in light of an evolving industry. The meeting was then summarized in a lengthy report written by the committee members. The report often took months to prepare and finalize, given the limited bandwidth of the industry representatives. The faculty then reviewed the report and offered comments and responses to the points raised in the report prior to initiating any curricular changes. Because curricular changes are also a lengthy process, the recommendations by the committee took years to be integrated into the curriculum.

Objective: The objective of the JEC meeting format improvement was to restructure the meeting so that it would yield outcome-oriented results (i.e., continuous improvement) on a more frequent basis.

JEC Meeting Format Improvement: In AY 2019-2020, the Department of Civil, Environmental, and Architectural Engineering made significant changes to its JEC meeting format. These changes included:

1. Changing the meeting frequency from triannual (meeting every three years) to occur annually. Reasoning: The program wished to receive more regular feedback to respond to changes occurring in the industry in a more timely manner;
2. Changing the meeting time from 8 hours to 2 hours. Reasoning: The program wished to focus the conversation and to lower the time commitment burden for industry professionals;
3. Sending a pre-read in advance that contained (a) the program objectives, (b) the previous year's JEC summary report, and (c) the current curriculum. Reasoning: The JEC representatives could review the necessary material on their own time rather than spending time in the actual meeting doing so;
4. Focusing the conversation to three major discussion points, namely (a) a review of program objectives, (b) an open discussion of required professional skills, and (c) an open discussion of required technical skills within the discipline. Reasoning: This focus kept the conversation structured to that the program received the most salient feedback with respect to the curriculum.
5. Summarizing a two-page report within a week of the meeting, soliciting industry feedback within the next week, and circulating to faculty over the summer and early fall to identify action items with respect to the program and curriculum. Reasoning: Curricular changes implemented in the fall semester take effect the following fall semester. The short summary and quick turnaround allow the faculty to implement important and timely changes on a much more frequent basis.

Impact: The new JEC format has been in effect for three (3) academic year cycles: AY 2019-20, AY 2020-21, and AY 2021-22. More frequent feedback from the JEC has enabled the faculty to make important and timely changes, such as (i) modifying the type and frequency of course offerings to reflect important skillsets needed in the industry (e.g., Embodied Carbon in Buildings, Design of Wood Structures), (ii) establishing our Student Pathways Committee that enhances our students' experience outside of the classroom, and (iii) establishing a mentorship program to connect our students with professionals in the industry, among many others. The program is thrilled with this new format, as it enables enhanced continuous improvement of our program to better serve our students and the fields in which they will enter.

Teaching Quality Framework Initiative

Introduction: Acknowledgment and value of teaching quality in reappointment, tenure, and promotion (RTP) systems remain a point of contention to those attempting to create more equitable, transparent, and formative evaluation methods for their work. To date, the Teaching Quality Framework Initiative (TQF), an ongoing initiative at the University of Colorado Boulder (CU-B), has been successful at helping departments transform their teaching evaluation practices. A common rubric that defines seven dimensions of quality teaching and draws from “three voices” of teaching evaluation - self, peer, and student is used as a guiding tool.

Purpose: Assessment of teaching practices were needed for the development of faculty in the CEAE department. A need for discipline-based, collegial, structured, and formative feedback was identified by the CEAE Teaching Quality Framework (TQF) Departmental Action Team (DAT).

Overview of Initiative: The Classroom Interview Process (CIP) in CEAE consists of three components: a pre-consultation between the participating faculty and CIP facilitator; the classroom observation and interview; and a post-consultation between the participating faculty and facilitator. The CIP was developed in the 2020-2021 academic year, piloted in spring 2021, and expanded starting in the fall of 2021.

Faculty Participation: To date, 11 CEAE faculty participated in the CIP in the fall semester of 2021, and 10 faculty participated in spring 2022. Courses observed span the 2000, 3000, and 4000 level across AREN, CVEN, and EVEN listings. Faculty participating in a CIP represented all six faculty groups. The faculty who facilitated a CIP during 2021-2022 represented a group that have received varied and prestigious teaching accolades, including college and department teaching awards and fellowships, engineering education authorship, and FTEP CLIP experience (e.g., ASCE ExCEED New Faculty Excellence in Teaching Award, Boulder Faculty Assembly Excellence in Teaching Award). Faculty who facilitated a CIP included faculty at the Assistant, Associate, and Full Professor designations. Table 4.29 below provides a breakdown of those who participated in a CIP in the fall 2021 and spring 2022 semesters.

Table 4.29. Breakdown of faculty who have completed CIP.

Faculty who have completed the classroom interview process to date			
# of faculty	Faculty groups represented (#)	Career level represented (#)	Peer letters provided
21	Building/Civil Systems (4) Construction (3) Environmental (5) Geotechnical (4) Structural (4) Water Resources (1)	Assist. Teaching Prof.(3) Assoc. Teaching Prof. (4) Assist. Prof.(11) Assoc. Prof.(1) Professor (2)	7+

Faculty Feedback on CIP: Based on post-consultation meetings with participating faculty, some senior faculty mentioned thinking the CIP was a helpful process for improving teaching. The pre-meetings with faculty were helpful in alleviating concerns and misconceptions about the process of the CIP and as a way for facilitators to emphasize the opportunity for the CIP to provide formative feedback.

Management of Initiative: Along with the formation / movement of a classroom interview committee, the following are tasks that help in managing the CIP as well as suggestions for delegation of these tasks:

- Requesting and compiling data for courses to be observed
 - Timing - This task takes approximately 2-4 hours to complete prior to the beginning of the semester that a CIP occurs
- Contacting identified and interested faculty
 - Timing - This task takes approximately 2-4 hours to complete prior to the beginning/first few weeks of the semester that a CIP occurs
- Scheduling of the CIP with faculty (3 meetings per CIP)
 - Timing - This task takes approximately 1-2 hours prior to the beginning/first few weeks of the semester that the CIP occurs
- Recruiting facilitators
 - Timing - This task takes a varied amount of time depending on the top-down messaging and any related incentives, ideally prior to the beginning of the CIP in a given semester
- Training facilitators
 - Timing - This task could take a varied amount of time depending on the top-down messaging and any related incentives, ideally prior to the beginning of the CIP in a given semester
- Preparing survey links, feedback spreadsheet, and bit.ly links for the CIP facilitator
 - Timing - This task takes approximately 2-4 hours prior to the beginning/first few weeks of the semester that the CIP occurs
- Sharing CIP survey links and feedback documents to facilitators
 - Timing - This task takes approximately 1-2 hours prior to the beginning/first few weeks of the semester that the CIP is occurs
- Answering questions from participating faculty
 - Timing - This task can occur as needed and as questions arise
- Soliciting feedback from participating faculty
 - Timing - This task can either be within a month of the participating faculty's CIP, or at the end of the semester of the CIP depending on the method of evaluation (e.g., focus group at the end of the semester vs survey sent within month of CIP)
- Presenting at select faculty meetings to address fears and goals of the CIP
 - Timing - Once per semester that the CIP will take place

Future Value: The TQF CEAE team believes that the CIP provides valuable formative feedback to faculty. There is also opportunity for participating faculty and the department to:

- Request and receive quality peer letters (if requested) for comprehensive review, reappointment, promotion, and tenure dossiers
- Receive credit for engaging in a CIP for facilitators and participating faculty for merit review purposes.
- Develop growth at the junior faculty and senior faculty levels, both for formative and remediation identification
- Use CIP for its fit within supplemental data collection options for the CEAS TQF model rubric for CRPT

C. Additional Information

The FE exam serves as a direct assessment method for 4 of our 7 student outcomes. The civil engineering exam requirements from the NCEES, performance reports from the NCEES on the performance of CU civil engineering students, and the full FE summary spreadsheet will be available for examination at the time of the visit.

Student reports and presentations in the senior capstone design course are used as direct assessments for four student outcomes. The rubric used in the course to assess these outcomes is presented in Appendix E. The course dossier will include current and historical data from the course rubric. Further, a quiz is used in the course to assess student knowledge of five additional outcomes. An example of this quiz is included in Appendix E and will also be available for examination in the design course dossier.

Assignments in other courses that are used to assess student outcomes—including laboratory reports and homework assignments from the Introduction to Civil Engineering course and the Professional Issues course—will be available for examination in files compiled for each relevant outcome, as well as the course dossiers.

CRITERION 5. CURRICULUM

A. Program Curriculum

The Civil Engineering curriculum is commonly referred to by students, faculty, and other constituents as a so-called “Block Diagram”. The block diagram lays out the expected and recommended order of courses to complete the requirements for the program in eight semesters (four academic years). The first semester is shown in the bottom row of the diagram, and subsequent semesters build to the final semester at the top. The block diagram indicates courses that are part of pre-requisite and co-requisite sequences in their proper order. Some courses are also offered only fall or spring semester, and those courses are shown in an appropriate location (and also denoted with a #). Students have opportunities to select a number of courses, including three Civil Engineering proficiency courses, five humanities and social science courses (HSS elective), two technical electives within Civil/Architectural Engineering, and two general technical electives. There are lists of acceptable courses for each of these choices.

The CVEN proficiency courses come from a list of six options. The technical elective list is quite extensive; it is periodically reviewed by the curriculum committee and published online for students (https://www.colorado.edu/ceae/sites/default/files/attached-files/ceae_tech_elective_list_oct_2020.pdf). HSS electives are vetted by the H&SS subcommittee of the CEAS and approved by the Undergraduate Education Council of the College. It includes courses offered by the Herbst Program for Engineering, Ethics & Society. It also includes courses approved as part of the College of Arts & Sciences General Education requirements in the topic areas of arts & humanities and social sciences. Additional courses have also been approved (<https://www.colorado.edu/engineering-advising/get-your-degree/degree-requirements/humanities-social-sciences-and-writing-requirements>). The curriculum also includes one free (minimally restricted) elective.

The curriculum is also shown in Table 5-1. Courses have been listed from first to eighth semester, in the same recommended order shown in the Block Diagram. The maximum section enrollments for all courses in the program for the last two terms the course was taught have been included. Many courses only have a lecture. Other courses also include recitations or laboratories, so the enrollment for those types of scheduled meetings is also shown.

CVEN Block Diagram – Fall 2021

Sem.	CR						
8 SPR	16	CVEN 4899-4cr Senior Design Project (See notes***) #	<u>Technical Elective-3cr</u>	<u>Technical Elective-3cr</u>	<u>Proficiency-3cr</u> See page 2		<u>HSS Elective-3cr</u> Upper-division
7 FALL	17	CVEN 4897-2cr Professional Issues in CVEN (Junior standing) #	<u>Technical Elective-3cr</u> AREN/CVEN only	<u>Technical Elective-3cr</u> AREN/CVEN only	<u>Proficiency-3cr</u> See page 2	<u>Free Elective-3cr</u>	<u>HSS Elective-3cr</u> Upper-division
6 SPR	15	CVEN 3227-3cr Probability, Stats., Decision for CVEN (Junior standing) #		<u>Proficiency-3cr</u> See page 2	CVEN 3111-3cr Analytical Mechanics 2 (CVEN 2121) #	<u>College-Approved Writing Course-3cr**</u>	<u>HSS Elective-3cr</u>
5 FALL	15	CVEN 3246-3cr Introduction to Construction (Junior standing)	CVEN 3323-3cr Hydraulic Engineering (CVEN 3313) #	CVEN 3414-3cr Fund. of Env. Eng. (CHEN 1201, APPM 1360)	CVEN 3525-3cr Structural Analysis (CVEN 3161)	CVEN 3708-3cr Geotechnical Engineering 1 (CVEN 3161)	
4 SPR	17	APPM 2360-4cr Introduction to Linear Algebra & Diff. Equations (APPM 1360)	CVEN 3313-3cr Theoretical Fluid Mechanics (CVEN 2121) #	AREN 2110-3cr Thermodynamics (PHYS 1110, co-req APPM 1360)	CVEN 3161-3cr Mechanics of Materials 1 (CVEN 2121, co-req APPM 2360)	CVEN 3698-3cr Engineering Geology (co-reqs CVEN 2121 and APPM 2350) #	CVEN 2017-1cr Excel and Matlab Primer (CSCI 1200) #
3 FALL	18	APPM 2350-4cr Calculus 3 for Engineers (APPM 1360)	PHYS 1120-4cr Gen. Physics 2 (PHYS 1110, co-req APPM 1360)	PHYS 1140-1cr Experimental Physics 1 (co-req PHYS 1120)	CVEN 2121-3cr Analytical Mechanics 1 (PHYS 1110, co-req APPM 2350*)	CVEN 2012-3cr Intro to Geomatics	<u>HSS Elective-3cr</u>
2 SPR	14	APPM 1360-4cr Calculus 2 for Engineers (APPM 1350)	PHYS 1110-4cr Gen. Physics 1 (co-req APPM 1350)		CVEN 1027-3cr OR AREN 1027-3cr Engineering Drawing	GEEN 1400-3cr Engrg. Projects OR Basic Engineering Elective	
1 FALL	16	APPM 1350-4cr Calculus 1 for Engineers (APPM 1235 or placement)	CHEN 1201-4cr Gen. Chem. for Engineers 1 (1yr HS chem. or CHEM 1021, HS algebra)	CHEM 1114-1cr Lab in General Chemistry 1 (co-req CHEN 1201)	CVEN 1317-1cr Introduction to Civil & Environ. Engineering #	CSCI 1200-3cr Intro to Computational Thinking #	<u>HSS Elective-3cr**</u>

Course is offered only once per year (FALL or SPRING as shown)

Fall 2021/Updated June 2021

() Prerequisite and co-requisite requirements for course listed.

* Co-requisite APPM 2350; OR co-requisite APPM 1360 and prerequisite GEEN 3830 Engineering Analysis & Problem Solving.

** College-approved writing courses: ENES 1010 (first-year students only); or ENLP 3100, ENES 3100, WRTG 3030, WRTG 3035, or PHYS 3050 (junior standing). Students who want to take ENES 1010 can switch the HSS elective in Term 1 with the writing course in Term 6.

*** Requisites for CVEN 4899: (pre-/co-reqs CVEN 3718 and 4728) or (pre-/co-reqs CVEN 3323 and 4333) or (prereqs CVEN 3256 and AREN 4506) or (prereq CVEN 4555 and co-req CVEN 4545) or (pre-/co-req CVEN 3424).

CVEN ELECTIVES AND AREAS OF FOCUS

Students must complete at least **three of the five** proficiency courses listed below (to ensure students can “design in more than one context”). Proficiency courses and recommended technical electives for each sub-discipline are listed below. For further suggestions, consult the Suggested Course Plan in the CVEN Advising Guide and your faculty mentor.

Students must complete one set of pre-/co-requisites for CVEN 4899 Senior Design from the options below.

GEOTECHNICAL ENGINEERING

Proficiency: CVEN 3718 Geotechnical Engineering II (CVEN 3708) – fall and spring

Recommended Technical Electives:

CVEN 4728 Foundation Engineering (CVEN 3718) – spring

CVEN 5708 Soil Mechanics (CVEN 3718 recommended, instructor consent) – fall

Any CVEN 5xx8 introductory graduate-level Geotechnical Engineering course (instructor consent)

Pre- or co-requisites for Senior Design: CVEN 3718 Geotechnical Engineering II and CVEN 4728 Foundation Engineering

WATER RESOURCES ENGINEERING

Proficiency: CVEN 4333 Engineering Hydrology (CVEN 3313, co-req CVEN 3227) – fall and spring

Recommended Technical Electives:

CVEN 4353 Groundwater Engineering (CVEN 3313) – fall

CVEN 5363 Modeling of Hydrologic Systems (CVEN 3323 or co-req CVEN 4333 recommended, instructor consent) – spring

CVEN 4383 Groundwater Modeling (CVEN 4353 recommended) – spring

CVEN 4323 Water Resources Engineering Design (Junior standing) – intermittent

Pre- or co-requisites for Senior Design: CVEN 3223 Hydraulic Engineering and CVEN 4333 Engineering Hydrology

CONSTRUCTION ENGINEERING AND MANAGEMENT

Proficiency: CVEN 3256 Construction Equipment and Methods (CVEN 3246) – fall and spring

Recommended Technical Electives:

AREN 4506 Pre-Construction Estimating and Scheduling (CVEN 3246) – fall and spring

AREN 4606 Construction Project Execution and Control (AREN 4506) – spring

Prerequisites for Senior Design: CVEN 3256 Const. Equip. & Methods and AREN 4506 Pre-Const. Estimating and Scheduling

STRUCTURAL ENGINEERING/ STRUCTURAL MECHANICS

Proficiency: CVEN 4545 Steel Design – spring or CVEN 4555 Reinforced Concrete Design – fall (CVEN 3525)

Recommended Technical Electives:

CVEN 4161 Mechanics of Materials II (CVEN 3161) – fall

CVEN 4545 or CVEN 4555 (whichever course not selected as proficiency)

CVEN 4525 Matrix Structural Analysis (CVEN 3525) – fall

Requisites for Senior Design: Prerequisite CVEN 4555 Reinforced Concrete Design and co-requisite: CVEN 4545 Steel Design

ENVIRONMENTAL ENGINEERING

Proficiency: CVEN 3424 Water and Wastewater Treatment (CVEN 3414) – spring

Recommended Technical Electives:

CVEN 4404 Water Chemistry/CVEN 4414 Water Chemistry Lab (CHEN 1203 or 1211, CHEM 1221, co-req CVEN 3414) – fall

CVEN 3434 Introduction to Applied Ecology (CHEN 1201 and CHEM 1114) – spring

CVEN 4474 Hazardous and Industrial Waste Management (CVEN 3414) – fall

CVEN 4484 Intro to Environmental Microbiology (CHEN 1201, CHEM 1114, APPM 2350) – spring

Pre- or co-requisites for Senior Design: CVEN 3424 Water and Wastewater Treatment

ELECTIVE REQUIREMENTS

Basic Engineering Elective – any 3-credit technical course given in the engineering college with a designator ASEN, AREN, APPM, CHEN, COEN, CVEN, CSCI, ECEN, EMEN, EVEN, GEEN, or MCEN, or other course approved by the CEAE Curriculum Committee. Remedial courses (precalculus, etc.) or courses approved as HSS electives may not be used.

Free Elective – Any college-level course, except: cannot be remedial courses needed to fulfill deficiencies (precalculus, introductory chemistry, etc.) and cannot be similar to other courses used toward graduation requirements (algebra-based physics, etc.).

Humanities and Social Science (HSS) Elective – See the College requirements and list of approved courses at www.colorado.edu/engineering/academics/policies/HSS.

Technical Elective – Generally, an upper-division (3000+) science or engineering course with technical content. All upper-division AREN/CVEN courses are technical electives; up to 6 credits outside of AREN/CVEN may be selected from the approved course list posted at <https://www.colorado.edu/ceae/node/111/attachment>. Up to 3 credits of independent study are allowed for technical elective credit.

Table 5-1 Curriculum: Civil Engineering

Course (Department, Number, Title) List all courses in the program by term starting with the first term of the first year and ending with the last term of the final year.	Indicate whether course is Required, Elective or a Selected Elective by an R, an E or an SE. ¹	Subject Area (Credit Hours)			Offered: Year and, Semester, or Quarter	Maximum Section Enrollment for the Last Two Terms the Course was Offered ²
		Math & Basic Sciences	Engineering Topics; Check if Contains Significant Design (✓)	Other		
Applied Mathematics, APPM 1350, Calculus 1 for Engineers	R	4			Spring 2023, Fall 2022	Spring 23-81 lec, 25 lab, Fall 2022-152 lec, 26 lab
Chemical Engineering, CHEN 1201, General Chemistry for Engineers	R	4			Spring 2023, Fall 2022	Fall 2022-350, Spring 2023-153
Chemistry, CHEM 1114, Lab in General Chemistry 1	R	1			Spring 2023, Fall 2022	20
Civil Engineering, CVEN 1317, Intro to Civil & Environmental Engineering	R		1		Fall 2022, Fall 2021	Fall 2022-92, Fall 2021-80
Computer Science, CSCI 1200, Intro to Computational Thinking	R		3		Fall 2021, Fall 2022	Fall 2022-195 lec, 45 lab, Fall 2021- 152 lec, 38 lab
HSS Elective	E			3		
Applied Mathematics, APPM 1360, Calculus 2 for Engineers	R	4			Spring 2023, Fall 2022	Spring 23-152 lec, 26 lab, Fall 2022-103 lec, 25 lab
Physics, PHYS 1110, General Physics 1	R	4			Spring 2023, Fall 2022	Fall 2022-330 lec, 28 lab, Spring 23-333 lec, 29 lab
Civil Engineering, CVEN 1027, Civil Engineering Drawing <u>OR</u> Architectural Engineering, AREN 1027, Engineering Drawing	R		3		Spring 2023, Spring 2022	Spring 2023-52 lec, 26 lab Spring 2022-50 lec, 25 lab
General Engineering, GEEN 1400, Engineering Projects	R		3✓		Spring 2023, Fall 2022	Fall 2022-32 lec, 31 lab, Spring 2023-30 lec, 30 lab
Applied Mathematics, APPM 2350, Calculus 3 for Engineers	R	4			Spring 2023, Fall 2022	Spring 23-80 lec, 24 lab, Fall 2022-111 lec, 25 lab
Physics, PHYS 1120, General Physics 2	R	4			Spring 2023, Fall 2022	Spring 23-300 lec, 29 lab, Fall 2022-337 lec, 28 lab

Physics, PHYS 1140, Experimental Physics 1	R	1			Spring 2023, Fall 2022	Spring 23-329 lec, 17 lab, Fall 2022-178 lec, 16 lab
Civil Engineering, CVEN 2121, Analytical Mechanics 1	R		3		Spring 2023, Fall 2022	Spring 2023-77, Fall 2022-106
Civil Engineering, CVEN 2012, Geomatics	R		3		Spring 23, Fa 22	36 lecture, 9 lab
HSS Elective	E			3		
Applied Mathematics, APPM 2360, Intro to Linear Algebra & Diff Equations	R	4			Spring 2023, Fall 2022	Spring 23-130 lec, 26 lab, Fall 2022-100 lec, 26 lab
Civil Engineering, CVEN 3313, Theoretical Fluid Mechanics	R		3		Spring 2023, Spring 2022	135 lecture, 135 lab
Architectural Engineering, AREN 2110, Thermodynamics	R	1	2		Spring 2023, Fall 2022	Fall 2022-106, Spring 2023-48
Civil Engineering, CVEN 3161, Mechanics of Materials 1	R		3		Spring 2023, Fall 2022	Fall 2022-48 lec, 24 lab; Spring 2023-84 lec, 48 lab
Civil Engineering, CVEN 3698, Engineering Geology	R	3			Summer 23, Spring 2022	48
Civil Engineering, CVEN 2017, Excel and Matlab Primer	R		1		Spring 2023, Spring 2022	24 plus online section
Civil Engineering, CVEN 3246, Introduction to Construction	R		3√		Spring 2023, Fall 2022	Spring 2023-64, Fall 2022-90
Civil Engineering, CVEN 3323, Hydraulic Engineering	R		3√		Spring 2023, Spring 2022	106 lecture, 22 lab
Civil Engineering, CVEN 3414, Fundamentals of Environmental Engineering	R		3		Spring 2023, Fall 2022	106
Civil Engineering, CVEN 3525, Structural Analysis	R		3		Spring 2023, Fall 2022	Spring 2023-48, Fall 2022-106
Civil Engineering, CVEN 3708, Geotechnical Engineering 1	R		3		Spring 2023, Fall 2022	Fall 2022-64 lec, 21 lab Spring 2023-48 lec, 24 lab
Civil Engineering, CVEN 3227, Probability, Statistics, and Decision for Civil Engineering	R		3		Spring 2023, Spring 2022	138
Civil Engineering, CVEN 3111, Analytical Mechanics 2	R		3		Spring 2023, Spring 2022	84
Technical Elective (Proficiency)	SE		3√			
College-Approved Writing Elective	SE			3		
HSS Elective	E			3		

Civil Engineering, CVEN 4897, Professional Issues in Civil Engineering	R		2		Fall 2022, Fall 2021	Fall 2022-78, Fall 2021-68
Technical Elective	SE		3√			
Technical Elective	SE		3√			
Technical Elective (Proficiency)	SE		3√			
Free Elective	E			3		
HSS Elective	E			3		
Civil Engineering, CVEN 4899, Senior Project Design	R		4		Spring 23, Spring 22	84
Technical Elective	SE		3√			
Technical Elective	SE		3√			
Technical Elective (Proficiency)	SE		3√			
HSS Elective	E			3		
TOTALS (in terms of semester credit hours)		34	73	21		
OVERALL TOTAL CREDIT HOURS FOR COMPLETION OF THE PROGRAM	128					
Total must satisfy minimum credit hours	Minimum Semester Credit Hours	30 Hours	45 Hours			

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.

Curriculum Alignment with Program Educational Objectives

The overall philosophy of the Civil Engineering curriculum is to provide all students with a broad foundation in engineering, followed by breadth across the various sub-discipline areas of civil engineering, and then allow the students choice to build additional breadth or depth in civil engineering, as well as related technical and/or non-technical areas (via technical electives, humanities and social science (HSS) electives, and free electives). This strong grounding in fundamentals and breadth enables the students to take their careers in multiple directions and solve problems that generally cross sub-disciplinary boundaries.

The **Program Educational Objectives** are linked to desired outcomes. The outcomes are fulfilled by various required courses in the curriculum, as described below. For example, all courses contribute to the knowledge and skills required for our alumni to be successfully employed in engineering, science, or technology careers (Program Educational Objective 1). The alignment of the curriculum with the program educational objectives is summarized below.

Table 5.1. Alignment of PEOs with CVEN Curriculum.

Objective	1 st yr courses	2 nd yr courses	3 rd year courses	4 th year courses	Notes
1. Successfully employed	All provide foundation	All provide foundation	All provide foundation	All provide foundation	Proficiency structure
2. Management or leadership			Intro Constr	Prof issues Senior design	
3. Continual learning				Senior design Prof issues	
4. Professional licensure	Intro CivE		Intro Constr	Prof issues Senior design	
5. Benefit communities	Intro CivE Humanities/ social sci electives	Humanities/ social sci electives	Fund. Env Eng Humanities/ social sci electives	Prof issues Senior design Humanities/ social sci electives	

Students are introduced to civil engineering in the Introduction to Civil Engineering course in the first semester. Then, students work to build basic science and mathematics knowledge, skills in geomatics/drawing, and breadth in humanities and social sciences in their other first year courses. These build to the engineering science courses that are largely in the sophomore and early junior year. The required fundamental courses in the breadth of civil engineering disciplines are taken fall semester junior year, from which the students are prepared to select their desired three areas of proficiency and civil engineering electives.

The preparation of our students to assume management and/or leadership roles after graduation (Objective 2) is largely accomplished through team-based courses, and specifically the Introduction to Construction course in spring junior year, Professional Issues course in fall senior year, and the capstone design course in spring senior year. Team experiences are included in nine required courses, and among these opportunities students are likely to assume management and/or

leadership roles. Alternatively, they experience different management and leadership styles in these groups, and develop an appreciation for more and less effective strategies.

Our students have ample opportunity to see why continual learning is important, and demonstrate the ability to teach themselves new material in the largely self-directed environment of the capstone design course. The courses that focus on life-long learning (contributing to Objective 3) are key to preparing our alumni to achieve the continual learning objective. Students are introduced to the importance of lifelong learning in the Introduction to Civil Engineering course in the first semester, and these ideas are reinforced in courses such as Introduction to Construction (junior year), and Professional Issues and capstone design (senior year).

The importance of pursuing professional licensure, to prepare graduates to achieve objective 4, is particularly emphasized in three key courses in the curriculum: Introduction to Civil Engineering (first semester), Introduction to Construction (fall junior year), Professional Issues (fall senior year), and Senior Design (spring senior year).

We expect graduates to be providing benefits to communities (Objective 5). Their humanities and social science electives help contribute to this goal along with courses that emphasize the impact of engineering on society.

Curriculum Alignment with Student Outcomes

All the required CVEN and AREN courses in the CVEN curriculum have been mapped to the extent to which they contribute to each of the 7 student outcomes, based on faculty ratings (per the 2-page course syllabi in Appendix A): large contribution (red), medium (orange), small (yellow), and none. The average student ratings on the course FCQs from the previous two rating semesters which range from 0 to 6 are shown as numbers in the figure below. Note that ratings vary by semester, and a few outcomes vary a lot when different instructors teach the course. Most instructors under-rate contributions to outcomes, in comparison to student ratings. Missing from the table are required courses in the curriculum outside of engineering. They primarily contribute to outcome 1, ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics [4 semesters of calculus and math; 2 semesters of physics, 1 semester of chemistry], outcome 6, an ability to analyze and interpret data, and use engineering judgment to draw conclusions. [Engineering Computing], and outcome 3, an ability to apply written communications to communicate effectively with a range of audiences. [Writing on Science & Society]. The humanities and social science electives [15 credits] contribute to outcome 7, ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

The three proficiency courses and two civil engineering electives taken by the students also contribute significantly to the achievement of the outcomes. But these will vary based on the specific courses selected by the students. The mapping of the proficiency courses and common civil engineering electives to the 7 outcomes is shown in an additional table below.

Table 5.2. Alignment of Required engineering courses in the CVEN degree mapped to Student Outcomes [faculty ratings: red = large, orange = medium, yellow = small]. N/A = data not available

Student Outcomes										
Courses [semester]	1	2a	2b	3a	3b	4	5	6a	6b	7
CVEN 1317-2 [1]										
CVEN/AREN 1027-1 [2]										
CVEN 2012-2 [2]										
AREN 2110-3 [3]										
CVEN 2121-3 [3]										
CVEN 3161-3 [4]										
CVEN 3313-3 [4]										
CVEN 3698-3 [4]										
CVEN 2017-1 [4]										
CVEN 3525-3 [5]										
CVEN 3323-3 [5]										
CVEN 3414-3 [5]										
CVEN 3708-3 [5]										
CVEN 3246-3 [5]										
CVEN 3111-3 [6]										
CVEN 3227-3 [6]										
CVEN 4897-2 [7]										
CVEN 4899-4 [8]										
Total # Large courses	16	8	7	1	3	1	2	3	8	4
Total # Medium courses	0	5	5	2	4	10	5	2	4	11

Engineering topics and design: Table 5-1 also shows that the program contains sufficient coverage (73 credit hours) to meet the engineering topics requirement, with >45 credit hours of the curriculum devoted to these topics.

General education: The curriculum provides 18 credits of humanities and social sciences coursework, including 6 credits that are upper-division and an upper-division writing course. The College provides a listing of approved courses for these electives (see <https://www.colorado.edu/engineering-advising/get-your-degree/degree-requirements/humanities-social-sciences-and-writing-requirements>) to ensure that the courses have sufficient quality and complement the technical portions of the curriculum; in general, courses that are “skills” oriented are not approved for these electives. Instead, the College’s list focuses on courses with a broad view of history, literature, and the humanities. Most these courses are approved as College of Arts & Sciences (A&S) general education courses, and as such undergo scrutiny from A&S to ensure quality. Courses beyond the A&S general education requirements that are approved for engineering students are reviewed and approved by the College’s Undergraduate Education Council. Students are encouraged to pick an area of humanities or social science and devote their humanities electives to courses in that single area. Many also choose to take advantage of the College’s Herbst Program for Engineering, Ethics & Society, as described in Appendix D.

Other: The Civil Engineering curriculum includes three credits of free electives. These credits were classified as “other”. They may be technical or non- technical courses. They provide students with a small amount of autonomy to customize their college experience. They may include study abroad courses, courses that contribute to a minor or certificate, etc.

In addition to the basic-level criteria, ABET specifies additional civil engineering program criteria, which are presented separately later in the Program Criteria section.

Major Design Experience

The major design experience taken by civil engineering students in their senior year before they graduate is fulfilled through CVEN 4899 Civil Engineering Senior Design (4 credits). This course provides students the opportunity to “practice their profession” in a simulated real world setting. Senior Design is the culmination of the civil engineering program which challenges students to combine their academic knowledge with practical considerations to solve “real- world” engineering problems that are subject to constraints including cost, schedule, technical, regulatory, and societal. The faculty members supporting this course provide little instruction in terms of what is common in most undergraduate classes (i.e. few lectures). Instead, the faculty members are to be used as a resource to support student teams during the process of designing and planning the project. One faculty member serves as an overall course coordinator, and additional faculty members representing each sub-discipline provide individualized mentoring on technical aspects. Guest speakers from industry join multiple classes to provide specific technical instruction as it relates to the project each year. Student teams are issued a Request for Proposal (RFP) at the beginning of the semester, mimicking a real-world design-build competition. Teams compete to win the mock design-build contract, chosen by the client and faculty. In preparing their proposals, student groups produce three separate major deliverable packages that include written reports, drawings and presentations for the first three (3) design stages of a project: Conceptual Design, Schematic Design and Design Development.

Although each semester requires different design solutions, the following list represents example deliverables required from each group:

1. General
 - Site Concept Plan
 - Written narratives with design calculations
 - Design alternatives and cost saving recommendations
 - Drawing package – The following list of drawings represents the minimum sheets to be provided. Additional sheets may be identified as the design progresses.
 - G1.X - Cover sheet, vicinity map and drawing index
 - C1.X - Site Concept Plan
 - C1.X - Demolition Plan
 - C2.X – Grading and Drainage Plan
 - C2.X - Site Sections if necessary
 - C2.X - Erosion Control Plan and Details
 - C2.X – Paving Plan
 - C3.X - Utility Plan
 - C4.X – Retaining Wall Elevation and Details
 - C5.X – Paving Details (Parking, curb/gutter, cross pans)
 - S1.X – Foundation Plan
 - S1.X – Framing Plans
 - S1.X – Other Structural Plans
 - S2.X – Structural Elevations
 - S3.X – Foundation Details
 - S3.X – Section Details
 - S3.X – Slab and Deck Details
 - S5.X – Typical Connection Details
 - P3.X – Plumbing riser diagram
2. Water
 - Stormwater design
 - Stormwater quality and quantity analysis
 - Potable/fire water design
 - Irrigation design (if applicable)
 - Hydraulic analysis
 - Map of flood depth and flood plain
3. Geotech
 - Fill specifications
 - Grading plan
 - Foundation design
 - Retaining wall design
 - Slope stability analysis
 - If fill is required, an evaluation of potential borrow locations
4. Structural
 - Structural design – substructure and superstructure

5. Construction
- Detailed cost estimate (design and construction) for full site development with quantity takeoff
 - Cost of Work shall include all work designed by your team plus assumptions for other site utilities (electrical, sanitary sewer, gas, teledata), earthwork and landscaping.
 - Value Engineering / Project Alternatives
 - Design and Construction Schedule
 - Formwork design for all concrete items noted above by structural engineer
 - Anticipated equipment list (all equipment, no hand tools)
 - Erosion Control Plan
 - Site Logistics and Phasing Plans

The specific projects vary from semester-to-semester. Recently they have been real projects of interest to local municipalities and non-profit groups.

The specific objectives for the course are:

1. Integrate the technical sub-disciplines of structural, geotechnical, water resources and construction to create a professional-level solution to the assigned project problem.
2. Gather relevant data, understand client needs, identify constraints, and identify and use applicable regulations, codes and standards.
3. Create feasible alternative designs and carry out value engineering analysis.
4. Prepare increasingly detailed designs and construction planning that satisfies the Owners goals and project's constraints while also conforming to relevant codes and regulations.
5. Prepare design documentation including design rationale and intent, design details and integrated project planning, scheduling and construction cost analysis to support each design stage.
6. Complete primary components of contract documents for client as well as basic specifications.
7. Present ideas, concepts and designs in a professional format to the client from the perspective of an engineering firm attempting to win a design-build contract.
8. Work in multi-disciplinary teams and in interdisciplinary formats as appropriate during different phases of the assignment.

Teams are typically composed of 4 to 6 students. The course also includes discussion of a variety of professional issues, which are facilitated via guest speakers with outcomes documented through a quiz at the end of the semester.

2022-23 Senior Design Prompt:

Gross Reservoir Expansion Project (see **Appendix E**)

Cooperative Education

Cooperative education is not allowed to satisfy curricular requirements addressed by the general or program criteria.

Course Syllabi

In Appendix A, a syllabus is included for each course used to satisfy the mathematics, science, and discipline-specific requirements required by Criterion 5 and applicable program criteria.

CRITERION 6. FACULTY

A. Faculty Qualifications

There are 43 tenured/tenure-track (T/TT) faculty (23 Professors, 9 Associate Professors and 11 Assistant Professors) and 6 Assistant/Full Teaching Professors or Full-time Instructors in the CEAE department. These faculty members are distributed among six specialty groups (see table below). See Table 6-1 for the qualifications of these faculty members, presented alphabetically. Table 6-2 gives the approximate percentage each member of the faculty devotes to civil engineering. The geotechnical faculty contribute almost solely to Civil Engineering. The construction and structures faculty contribute about equally to both the Civil and Architectural Engineering programs. The water resources faculty contribute about equally to the Civil and Environmental Engineering programs. Many of the environmental engineering faculty contribute little to the Civil Engineering program, primarily teaching courses for the Environmental Engineering program. The building systems group contributes mostly to the Architectural Engineering program, being primarily associated with the lighting, electrical, and mechanical engineering areas of Architectural Engineering. All CEAE faculty vote on objectives, outcomes, and curriculum matters, and as such have some contribution to the civil engineering program.

Specialty	Approx. % to CVEN Program	Full professors	Associate Professors	Assistant Professors	Asst. or Full / Teaching Professors or Full-Time Instructors
Geotechnical	100	4	1	3	0
Water Resources	50	4	3	0	0
Structures	50	3	3	0	0
Construction	50	3	0	2	2
Environmental	20	6	1*	5	1
Building Systems	10	3	1	1	3
Total	-	23	9	11	6
Adjusted for CVEN	-	~10.5	~4.3	~5.0	~1.5

*Includes Prof. Evan Thomas, Director of the Mortensen Center in Global Development.

The faculty are highly diversity, with 14 T/TT (33%) and 3 teaching professors (50%) on the faculty that identify as women, at least three T/TT faculty who identify as LGBTQ+ (7%), and four T/TT and teaching professors from underrepresented minority populations (8%).

Eleven T/TT faculty members (~25%) have received the prestigious NSF CAREER award. Awardees include Professors Prof. John Crimaldi, Prof. Roseanna Neupauer, Prof. Mark Hernandez, Prof. Matthew Hallowell, Assoc. Prof. Wil Srubar, Assoc. Prof. Mija Hubler, Assoc Prof. Sherri Cook, Prof. Abbie Liel, Asst. Prof. Kyri Baker, Asst. Prof. Fatemeh Pourahmadian, and Assoc. Prof. Shideh Dashti.

Two faculty members, Prof. Diane McKnight and Prof. Bernard Amadei, are members of the National Academy of Engineering (NAE). Three faculty members, Prof. Fernando Rosario-Ortiz, Prof. Keith Molenaar, and Prof. Evan Thomas, in CEAE hold endowed chair positions. Four faculty members, Prof. Amy Javernick-Will, Prof. Karl Linden, Prof. Matthew Hallowell, and Prof. Mark Hernandez, hold endowed professor positions. Six faculty members, Prof. Sherri Cook, Prof. Abbie Liel, Prof. Wil Srubar, Prof. Joseph Kasprzyk, and Prof. Matthew Morris, and Prof. Sandra Vásconez, hold fellow positions.

Our faculty have been recognized for teaching excellence and educational research. Multiple faculty members, including Prof. Roseanna Neupauer, Prof. Wil Srubar, Prof. Azadeh Bolhari, and Prof. Amy Javernick-Will, have received the ExCEED New Faculty Excellence in Teaching Award from the American Society of Civil Engineers (ASCE). Three faculty have been recognized as a University of Colorado Boulder President's Teaching Scholar, including Prof. Roseanna Neupauer, Prof. Angela Bielefeldt, and Prof. Matt Hallowell. Prof. Roseanna Neupauer, Prof. Matt Hallowell, and Prof. Kyri Baker received the University of Colorado Boulder College of Engineering and Applied Sciences John and Mercedes Peebles Innovation in Education Award in 2010, 2012, and 2022, respectively. Prof. Roseanna Neupauer, Prof. Matt Hallowell, Prof. Abbie Liel, and Prof. Matt Morris received the University of Colorado Boulder College of Engineering and Applied Sciences Charles A. Hutchinson Memorial Teaching Award in 2008, 2010, 2012, and 2022, respectively. Prof. Roseanna Neupauer received the 2011 Boulder Faculty Assembly Excellence in Teaching Award and the University of Colorado Boulder College of Engineering and Applied Sciences 2010 Sullivan-Carlson Innovation in Teaching Award. Prof. Keith Molenaar, Prof. Abbie Liel, and Prof. Amy Javernick-Will, Prof. Matt Hallowell, Prof. Sandra Vasconez, and Prof. Joe Ryan received the University of Colorado Boulder College of Engineering and Applied Sciences Outstanding Advisor Award, which recognizes one faculty and one staff advisor who demonstrate exceptional advising skills, in 2020, 2015, 2014, 2013, 2011, and 2010, respectively. Prof. Bielefeldt has won twelve (12) Best Paper awards for her pioneering engineering education research at the 2009 and 2015, 2016, 2017, 2018, and 2020 American Society of Engineering Education (ASEE) Annual Conferences.

B. Faculty Workload

Standard Teaching Load

The standard teaching expectation for research-active, tenured and tenure-track faculty is three courses or course equivalents per academic year, in addition to mentoring individual students in research. The department defines course equivalents to provide greater weighting for courses that have very large enrollments or more than three credits, or reduced weighting for courses with small enrollments, less than three credits, or team teaching. The standard teaching weight for evaluation purposes is 40% and includes individual mentoring in addition to courses.

Reductions in Teaching Load

Research-active faculty are allowed to “buy down” their teaching responsibilities to two courses per academic year. Buydown typically requires payment of 10% of the academic-year salary from research or service funds, though the amount may vary among the

departments. Newly hired faculty are typically provided with two years of a reduced teaching load of two courses per year, without buydown, though some departments may extend this startup period and others may provide one semester off from classroom teaching. Faculty whose salaries are rostered in a research institute also typically have a reduced teaching load of two courses per year and an increased research expectation. Other reasons for reductions in teaching loads include the awarding of Dean's Faculty Fellowships and administrative appointments such as Department Chair and require approval by the Dean. The teaching weight for evaluation purposes may be reduced when there is a reduction in teaching, but it may not be less than 25% without approval of the Dean and it should account for both course instruction and individual mentoring.

Increases in Teaching Load

Faculty who are less research active are expected to contribute to their departments with additional teaching and/or service. The individual departments may select other criteria to determine when an increase in teaching load is warranted. A one-year "grace period" is recommended before increasing a faculty member's teaching load, to provide an opportunity to rebuild his or her research program. Also, with approval of the Department Chair or Program Director, a faculty member may have an increased teaching load in one academic year and then a reduced teaching load in a subsequent year, which is known as "course banking." The teaching weight for evaluation purposes may be increased when there is an increase in teaching, but it may not be more than 55% without approval of the Dean.

Guidelines on Teaching loads can also be found here:

<https://www.colorado.edu/engineering-facultystaff/guidelines-teaching-loads-tenured-tenure-track-faculty>

C. Faculty Size

Faculty Size and Undergraduate Teaching

There is an adequate faculty size to teach and mentor civil engineering students, as shown above. The table below shows the number of Full Time Equivalent (FTE) Faculty, student credit hours (SCH) taught by CEAE faculty, and total number of undergraduate students. CEAE has been below the CU CEAS average for number of student credit hours (SCH) per faculty since 2013; CEAE is currently near our lowest level in 10 years. SCH are a good metric since our faculty teach courses that serve civil engineering, architectural engineering, and the bulk of the environmental engineering degree.

Fall Semester:	2018	2019	2020	2021	2022
Tenure-Line Faculty	41	38	41	42	39
Tenure-Line Budgeted Elsewhere	3	4	4	4	4
Instructional Faculty*	4	5	12	13	13
SCH, all CEAE	13,708	13,789	13,548	14,268	12,607
CEAE SCH/Faculty	286	293	238	242	225
CU CEAS College SCH/Faculty	429.8	430.6	421.7	409.7	N/A
# architectural engineering undergraduate students	149	156	154	161	145

***This number includes adjunct, post-doctoral researchers, or Ph.D. student instructors that fill vacancies due to sabbatical or in-process hires.** The number of permanent instructional faculty is six (6).

In addition to full- and part-time faculty, some individuals are hired to teach specific courses. Occasionally, post-doctoral researchers or Ph.D. students who are building their teaching skills will teach courses under the mentoring supervision of their advisor. More often, highly qualified senior individuals have been hired to teach courses. The table below summarizes the individuals who have been hired to teach specific courses in recent years, their qualifications, courses that they have taught, which semester(s), and average student ratings on the FCQs. The FCQ ratings are on a scale of 1-6 [1 = lowest, 6 = highest], and results for two questions are reported below: course overall and instructor overall.

Name	Qualifications	Courses Taught (type), dates [FCQs on scale of 1-6]
Lance Cayko	<ul style="list-style-type: none"> - Master's Architecture 2008 from North Dakota State University - Licensed architect in CO 2015 - Project Manager with Studio H:T (1 yr) - Owner and co-founder of F9 Productions (2009-present) residential BIM projects 	AREN 1027 Engineering Drawing (required), Fall 2017-Fall 2021 [Course 4.1-5, Instructor 4.5-5.4]
Rebecca Atkins	<ul style="list-style-type: none"> - BS Civil Engineering, Colorado School of Mines - Armstrong Consultants, Inc. Engineering Project Coordinator - Project Manager, Colorado Department of Transportation - SERVICE TO PROFESSION. - Extensive experience in transportation systems, asphalt pavements, project management. 	CVEN 4899 Senior Project Design, Spring 2023 [Course: 4.5-5.4, Instructor: NA (first term teaching)]

Name	Qualifications	Courses Taught (type), dates [FCQs on scale of 1-6]
Charles Beamer	<ul style="list-style-type: none"> - BS, MS, PhD Architectural Engineering, University of Colorado Boulder - Principal Illuminating Engineer, Acuity Brands, Boulder, Colorado - Senior Instructor, University of Colorado Boulder - Extensive experience in lighting and acoustics. 	<p>AREN 3440 Architectural Daylighting Design, Fall 2021, <u>rating on a scale 1-5</u> [Course: 3.75-4.38 Instructor: 2.75-4.29]</p>
Alex Gore	<ul style="list-style-type: none"> - Masters of Architecture - Masters Degree in Construction Management, North Dakota State University - Founder and co-owner of F9 Productions (2009-present) serving as designer and project manager for multiple residential and commercial BIM projects. 	<p>AREN 1027 Engineering Drawing (required), Fall 2017-Fall 2022 [Course 4.1-5.1, Instructor 4.4-5.6]</p>
Mark Jongewaard	<ul style="list-style-type: none"> - Master of Science, Civil Engineering, Illumination Emphasis, University of Colorado, May 1991. - President & Principal, LTI Optics, LLC - Adjunct Professor, University of Colorado - Board Member, Rocky Mountain Lighting Academy and Council for Optical Radiation Measurements. - Extensive experience in lighting software development, lighting and optical analysis, illumination optical design and training. 	<p>AREN 4130 Optical Design, Fall 2018, Spring 2020, Fall 2021, [Course: 4.4-5.5, Instructor: 5.2-5,8]</p>

Name	Qualifications	Courses Taught (type), dates [FCQs on scale of 1-6]
Joann Silverstein, PE, PhD (Professor Emerita)	<ul style="list-style-type: none"> - PhD Civil Engineering, University of California Davis - Professor, University of Colorado Boulder - Extensive expertise in wastewater treatment, water treatment, nutrient management, statistical modeling of wastewater systems, nutrient emissions trading. 	CVEN 4147 Civil Engineering Systems, Fall 2017-Fall 2022 [Course: 3.6-4, Instructor: 3.8-5.9]
James Zarske, PE	<ul style="list-style-type: none"> - MS Architectural Engineering, University of Colorado Boulder - Noresco, Director of Sustainability Services - NExant, Senior Engineering Manager - SERVICE TO PROFESSION. - Licensed PE, CEM, LEED AP and is currently a Director of Sustainability Services at NORESCO. He has over 20 years of engineering experience with a focus on building energy efficiency and sustainable design. 	AREN 5020 Building Energy Units, Spring 2023 [Course: 4.7-5.1, Instructor: NA (first term teaching)]

Faculty-Student Interactions

CEAE faculty members are actively involved in advising and mentoring students in the civil, architectural, and environmental engineering programs. Normally each CEAE faculty member advises 6 to 20 undergraduate students, meeting individually with each advisee in each semester of their junior and senior year. Details of the student academic advising have been provided in **Criterion 1: Students (Section D: Advising and Career Guidance)**. Faculty help students prepare for engineering careers by finding internships, reviewing student's resumes and bringing professional colleagues to meetings of student societies, special seminars and to classes as guest speakers. Through supervision of undergraduate research opportunities and independent study projects, faculty encourage many undergraduate Civil Engineering students to continue their studies at the Masters level in accordance to the expectations imposed by industry (e.g. the structures field expects students to have earned master's degree upon graduation), either at the University of Colorado or other universities.

Faculty members advise student chapters of professional societies such as Association of General Contractors (AGC), Illuminating Engineering Society of North America (IESNA), Architectural Engineering Institute (AEI), and Society of Women Engineers (SWE). One Civil Engineering faculty member founded Engineers Without Borders - USA (EWB-USA), with the first student chapter at the University of Colorado Boulder. EWB has engaged students to work with practitioners to help communities in developing countries with projects for sustainable infrastructure for water, sanitation, housing, and transportation. This concept of outreach education and service has captured the enthusiasm of many engineering students, and there are now EWB-USA student chapters at about half of all engineering programs throughout the US.

University Service Activities

Each faculty member serves on at least one standing Department Committee (e.g., Graduate, Curriculum, Operations, Computers, Facilities, Executive, Student Pathways Committee, Justice, Equity, Diversity, and Inclusion (JEDI)). In addition, faculty members serve on dozens of committees at the College and University level for developing curriculum, program evaluation, searches for new faculty and administrators, promotion, awards and fellowships, etc. Faculty resumes in **Appendix B** show the diversity of faculty service to the University community.

Professional Service and Interaction with Practitioners

Most CEAE faculty members are involved in 2 to 10 committees for national professional engineering societies, involving such diverse activities as evaluating revisions in building and material codes, peer review of proposed environmental and health regulations, and development of national research programs. Some examples are: American Society for Testing Materials (ASTM), American Society of Civil Engineers (ASCE), American Ceramic Society (ACerS), American Concrete Institute (ACI), and American National Standards Institute (ANSI) code-evaluation committees, and specialty committees within ASCE, the IESNA, ASHRAE, WEF, and AWWA. Faculty members chair sessions at national and international technical conferences and have themselves been conference directors. Many faculty members volunteer their professional expertise to community boards and public groups such as the Colorado municipalities and state agencies. All these activities regularly bring faculty in contact with their practicing colleagues in Civil and Architectural Engineering. Details of these activities are in the faculty resumes in **Appendix B**.

D. Professional Development

The department, college, and campus provide considerable resources to support faculty throughout their careers. New tenure-track faculty are provided with start-up packages that allow them to develop robust research programs and integrate themselves into the life of a department. In addition to the funding provided in their start-up packages, new tenure-track faculty are given reduced service and teaching responsibilities and are encouraged to take part in campus workshops to help them thrive in all aspects of their faculty roles. New instructional faculty are provided more modest start-up funds, typically used to cover computer equipment, a course development stipend (in the summer before starting their role), and conference registration. The University of Colorado places a priority on supporting faculty.

Through the Leadership Education for Advancement and Promotion (LEAP) Program, pre-tenure faculty have an opportunity to participate in an Introductory Leadership Workshop with other junior tenure-track faculty. This is a two-and-a-half-day, skill-based workshop held on campus two to three times each year. The Center for Teaching and Learning provides professional development support to all educators—both regular and temporary (i.e., lecturers and adjuncts)—on the CU Boulder campus. And, starting with AY 2022, the College is supporting new faculty hired through the college-wide search process to participate in the National Center for Faculty Development & Diversity (NCFDD) Faculty Success Program (FSP). FSP is a twelve-week program intensive focused on supporting new tenure-track faculty learn as they learn strategies for greater success in and securing external funding for and publishing their research.

The college and the campus provide assistance in grant writing in the form of workshops and direct resources through the Research Support Office. Of particular importance are a series of intensive workshop activities centered around the submission of NSF CAREER Awards and providing insight into key differences between how NSF criteria of Intellectual Merit, Broader Impacts, and Broadening Participation are scored during reviews.

Senior, tenured faculty members also receive ongoing support. The University has moved toward formal professional planning and development of faculty via in-depth Post-Tenure Review of every faculty member every five years. In addition, every tenure-track faculty member maintains a Professional Plan (updated every 5 years), detailing the professional growth of the faculty member and concrete plans for achieving that growth. This periodic review provides a valuable venue for enhancing the professional development of all our faculty members. For instructional faculty, the reappointment and promotion process now includes a self-reflection statement on teaching philosophy and experiences that provides an opportunity for reviewers to gain greater insight into the work that the faculty members are doing and provides an opportunity for feedback. Below are examples of activities faculty have pursued for professional development:

Faculty member name	Professional Development Example
Jeremy Andryauskas	Recent training in Bentley Open Roads Designer. Constant training in Autodesk AutoCAD Civil 3D.
Bernard Amadei	(i) Writing of three new books to be published in 2023 and 2024. (ii) Board members of several NGOs, (iii) Development of peace engineering initiative with other universities.
Angela Bielefeldt	ASEE Annual Conference & Exposition, 2022, 2021, 2020, 2019, 2018, 2017 Audited EDUC 8165 SpTpcs: Research on Equity Focused Programs in STEM. Prof. Edd Taylor. Fall 2020. Audited EDUC 8165 SpTpcs: Theories of Math & Science Learning. Prof. Hand. Sp2020.
Shideh Dashti	CU Boulder Today news articles on the Turkey Earthquake and “Pioneering Resilient Infrastructure” Organization of the “Women in Engineering” event 3/8/23

Gregor Henze	Time Series Analysis with a Focus on Modeling and Forecasting in Energy Systems, Danish Technological University, Copenhagen, Denmark, August 15-19, 2022.
Michael Gooseff	I regularly attend and present at national and international scientific conferences.
Yu-Hsuan Lee	Engineering Mechanics Institute Conference 2022 Research of DEM simulations and constitutive analysis of hyper-velocity penetration
Sheldon Masters	National Center for Faculty Development & Diversity Faculty Success Program.
Matthew Morris	Organization of Construction Diversity Summit Discussion of Marshall Fire experience and rebuilding on the “Concrete Credentials” podcast
Roseanna Neupauer	Attended short course on Modflow-6, 2019 Audited course on The Arctic Environment, 2022
Fatemeh Pourahmadian	<i>Engineering Mechanics Institute Conference</i> , Johns Hopkins University, Baltimore, MD <i>SIAM-CSS</i> , Oklahoma State University, OK.
Chris Senseney	Transportation Research Board, Annual Meeting, Washington, D.C., January 8-12, 2023 Climate Across the Curriculum Workshop, University of Colorado, Boulder, August 8-9, 2022 Undeually Training, University of Colorado, Boulder, March 2, 2022. Transportation Research Board, Annual Meeting, Washington, D.C., January 9-13, 2022
Cristina Torres-Machi	Participant in Game Changer Academies (CGCA) organized by the Civil, Mechanical and Manufacturing Innovation (CMMI) Division of the National Science Foundation. December 2022 – May 2023. 35 hrs. Participant in ExCEED (Excellence in Civil Engineering Education) Teaching Workshop organized by ASCE. Summer 2019. 40 hrs.
Yunping Xi	ICIC virtual webinar, Nov. 16-17, 2021 International Conf. on Plasticity, Damage & Fracture (ICPDF), Punta Cana, Dominican Rep., Jan. 3-9, 2023
John Zhai	Has been actively engaged in developing new curriculum in sustainable building development for both developed and developing countries, which led to the successful establishment of several international post-graduate programs (e.g., for Brazil, Mexico, Indonesia, and China). Has an established track record of collaboration with specialists in different engineering and non-engineering areas, such as, architecture, ecology, evolutionary biology, and public health etc. These collaborations have led to a specialization in interdisciplinary research topics.

	Has been actively involved in several professional societies (as the Fellow of ASHRAE, ISIAQ, IBPSA), promoting effective communications between academia and industry.
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The College provides overarching guidelines for faculty mentoring. The college holds a new faculty orientation program at the start of the academic year for tenure-track and instructional-track faculty. The Dean delivers a mentoring workshop at orientation, and new faculty and their mentors are invited to attend. Assignments of faculty mentors for new faculty are tracked by the Dean. In addition, the Dean has written a document on mentoring for faculty, Tips for Faculty Mentoring (see <http://www.colorado.edu/engineering-facultystaff/tips-faculty-mentoring>).

College Supported Programs:

The College supports the professional development of faculty through the Faculty Excellence Program, which provides a number of financial support opportunities. (See <http://www.colorado.edu/engineering-facultystaff/awards-incentives/college-awards/faculty-excellence-program>). This program includes:

- **Dean's Faculty Fellowships** - Selected faculty members are given one semester off from teaching a course, to focus on a major initiative in research and scholarly work or development of substantial educational materials or initiatives
- **Dean's Seed Funds for Novel Ideas** - Discretionary funds up to \$10,000 (\$15,000 if multiple units involved) provide seed support for new ideas, and are matched 1:1 by the department or program
- **Dean's Performance Awards** - \$5,000 awards are given for top performance in categories such as research, teaching, professional progress, and overall performance of junior faculty, based on the annual performance evaluations for the prior calendar year
- **Matching funds** for research grants, laboratory renovation funds, and travel to funding agencies
- **Sabbatical Supplement Program** - This program offers an additional 20% of the academic-year salary to faculty members taking full-year sabbaticals, on top of the normal 50% of the academic-year salary that they receive on sabbatical. The department then retains the remaining 30% of the academic-year salary, and the faculty member is responsible for raising (or forgoing) 30% of her or his salary. In addition, the Dean will provide \$4,000 in discretionary funds for research, travel, etc. to each faculty member who successfully applies for this program.

All tenured faculty members are eligible for sabbatical after each six years of full-time service. The sabbaticals may either be one semester at full pay or two semesters at half pay. The College of Engineering and Applied Science created a sabbatical supplement program, in which faculty are provided an additional 20% of their salary (70% total) for full-year sabbaticals, with the department keeping the other 30% for teaching replacement. These faculty members also receive \$4,000 in discretionary funds from the dean. It is expected that the faculty member will use the sabbatical assignment in a manner that will enhance his/her scholarly and/or teaching competence and potential for service to the University in addition

to advancing departmental program goals. A sabbatical assignment is an important tool in developing academic scholarship and is a time for concentrated professional development. More information can be found at: www.colorado.edu/facultyaffairs/career-milestones/leaves-and-sabbaticals/sabbaticals

Senior and Principal Instructors are now eligible to apply for differentiated workload semesters that provide full release from classroom teaching for one semester so that the faculty member can focus on a major teaching-related professional development project. As with tenure-track faculty, these opportunities require six years (twelve semesters) of continuous teaching service prior to application. Faculty receive full pay during the semester in which they have teaching relief.

The Center for Teaching & Learning supports CU's community of educators (including lecturers and adjuncts) through free consultations, teaching resources, programs, seminars, workshops, and other events. The CTL aims to cultivate attitudes toward teaching that are open, curious, and innovative. As a Center, they invite educators to an open, common space where all are welcome to explore teaching practices, pose questions, have brave conversations, take creative risks, and embrace intellectual humility.
<https://www.colorado.edu/center/teaching-learning>

Financial Support Opportunities:

- Sabbatical assignments (tenured faculty only)
- Provost's faculty achievement awards: research grants for assistant and associate professors.
- Faculty conference awards from the Office of the Vice Chancellor (VC) for Research
- Innovative seed grant program from the Office of the VC for Research
- Hazel Barnes prize for "enriching interrelationship between teaching and research" - \$20,000
- Boulder Faculty Assembly (BFA) Award for Excellence in Teaching - \$3,000
- BFA Awards for Excellence in Service - \$3,000
- BFA Awards for Excellence in Research, Scholarly, and Creative Work - \$3,000
- Boettcher Foundation, Webb-Waring Biomedical Research Awards
- Butcher Symposium in genomics and biotechnology

Recognition Awards:

- President's Teaching Scholars
- Distinguished Professor title (promotional opportunity for exceptional full professors)
- Alumni Association award

E. Authority and Responsibility of Faculty

The following is copied from the College Rules (Approved: November 1, 2022)

<https://www.colorado.edu/engineering-facultystaff/rules-policies/college-rules>

1. **The Faculty.** The members of the faculty shall consist of all Professors, Associate Professors, Assistant Professors, Principal Instructors, Senior Instructors, Instructors, Scholars in Residence, Research Professors, Research Associate Professors, and Research Assistant Professors in the College of Engineering and Applied Science on the Boulder campus. The Dean may also appoint members to one-year renewable terms from departments outside the College involved in degree-granting programs such as Engineering Physics and Applied Mathematics. These additional members may be recommended for membership at the start of each academic year by their respective department chairs. Other additional members outside the College may be appointed by the Dean for one-year renewable terms.
 - a. **Voting Members.** The voting membership of the faculty shall consist of all Professors, Associate Professors, Assistant Professors, Research Professors, Research Associate Professors, Research Assistant Professors, Scholars in Residence, Principal Instructors, Senior Instructors, and full-time Instructors in the College of Engineering and Applied Science, plus any additional members appointed by the Dean. Faculty with such titles as adjunct, adjunct, visiting, lecturer, research associate, etc., are not voting members of the College but may be voting members of a department (or program) based on the rules of that unit.
 - b. **Powers.** The college faculty shall collaborate with the Dean in the governance of the College of Engineering and Applied Science in all matters that concern only the College (in accordance with the Laws of the Regents, Article 4.A). In particular, through shared governance with the administration, the faculty shall have principal responsibility for academic and scholastic policy and ethics, and the faculty shall act jointly with the administration in areas of faculty appointment and review, regulation of student conduct and activities, budgeting review and resource recommendations, selection of academic administrators, determination of candidates for degree, and other policies concerning the general academic welfare of the College (in accordance with the Laws of the Regents, Policy 5.A.1).
 - c. **Faculty Meetings.** Faculty meetings shall be held at least once during each of the fall and spring semesters. Special meetings may be called by the Dean or shall be called by the Dean upon the written request of five members of the faculty. Twenty-four hours' notice of a special meeting will be given. The members present at any regular or special meeting shall constitute a quorum.
2. **Dean of the College of Engineering and Applied Science.** The Dean of the College shall be its administrative head. The Dean shall be responsible for the enforcement of admission requirements and for the general efficiency of the College and its departments and programs, and has overall responsibility for budgetary planning and allocation of funds, space and other resources, faculty assignments and workloads, recommendations on personnel actions, planning, accountability and reporting (in accordance with the Laws of the Regents). The Dean shall enforce rules and regulations of the College. The Dean shall confer with the Department Chairs about departmental needs. The Dean shall make regular reports to the Provost of the Boulder Campus, and to the faculty of the College.

The Dean of the College of Engineering and Applied Science reports to the Provost. The Provost leads the Division of Academic Affairs at the University of Colorado Boulder. The

Division of Academic Affairs is responsible for administering the academic programs and policies of the Boulder campus, and for providing intellectual leadership for excellence in teaching, scholarship, and creative work. The division recruits faculty, deans, and other academic leaders, and allocates resources to ensure high-quality teaching, research and creative work, and service. The Provost reports to the Chancellor, who in turn reports to the President of the University of Colorado.

Table 6-1. Faculty Qualifications

Civil Engineering

Faculty Name	Highest Degree Earned- Field and Year	Rank ¹	Type of Academic Appointment ² T, TT, NTT	FT or PT ³	Years of Experience			Professional Registration/ Certification	Level of Activity ⁴ H, M, or L		
					Govt./ Ind. Practice	Teaching	This Institution		Professional Organizations	Professional Development	Consulting/summer work in industry
Bernard Amadei	Ph.D. 1982	P	T	FT	22	44	41	N/A	H	M	M
Jay Arehart	Ph.D. 2021	AST	NTT	FT	5	3	3	Engineer in Training	M	H	H
Kyri Baker	Ph.D. 2014	AST	TT	FT	3	6	6	N/A	L	L	H
Rajagopalan Balaji	Ph.D. 1995	P	T	FT	0	23	23	N/A	H	M	L
William Becker	Ph.D. 1995	O	NTT	PT	40	30	4	New York PE	M	H	H
Angela Bielefedt	Ph.D. 1996	P	T	FT	4	27	27	Professional Engineer	L	H	L
Azadeh Bolhari	Ph.D 2013	ASC	NTT	FT	1	10	3	PE	H	H	L
Amelia Celoza	Ph.D. 2022	AST	TT	FT	3	2	2	OSHA Engineer in Training	H	H	L
Sherri Cook	Ph.D 2014	ASC	T	FT	N/A	9	10	N/A	M	L	L
John Crimaldi	Ph.D, 1998	P	T	FT	4	25	24	N/A	M	L	L
Shideh Dashti	Ph.D. 2009	ASC	TT	FT	2	12	12	N/A	H	M	L
Michael Gooseff	Ph.D. 2001	P	T	FT	4	21	8	Engineer in Training	H	M	L
Matthew Hallowell	Ph.D 2008	P	T	FT	4	15	15	N/A	M	M	H
George Hearn	D.E.S. 1989	ASC	TT	FT	35	35	35	Professional Engineer	H	M	H
Gregor Henze	Ph.D. 1989	P	T	FT	15	34	15	Professional Engineer ASHRE-certified HBDP	H	M	H

Mark Hernandez	Ph.D. 1994	P	T	FT	5	27	26	California Registered Professional Engineer	H	M	H
Mija Hubler	Ph.D. 2013	ASC	TT	FT	0	9	9	N/A	M	L	L
Amy Javernick-Will	Ph.D. 2009	P	T	FT	8	14	14	LEED AP	H	H	L
Joseph Kasprzyk	Ph.D. 2013	ASC	TT	FT	0	11	11	N/A	M	M	L
Rita Klees	Ph.D. 1989	O	NTT	PT	20	16	16	N/A	M	L	L
Julie Korak	Ph.D. 2014	AST	TT	FT	3	5	5	PE, Colorado	M	M	L
Moncef Krarti	Ph.D. 1989	P	T	FT	3	32	32	Professional Engineer LEED AP	H	M	L
Richard Kuchenrither	Ph.D. 1992	O	NTT	FT	40	17	17	PE Colorado, Nebraska, Nevada	H	L	H
Abbie Liel	Ph.D. 2008	P	T	FT	17	16	15	PE, California	H	L	H
Karl Linden	Ph.D. 1997	P	T	FT	2	25	17	EIT, BCEEM (Board Certified Environmental Engineering Member)	H	M	L
Benjamin Livneh	Ph.D. 2012	ASC	TT	FT	3	13	11	N/A	H	M	M
Shrikanth Madabhushi	Ph.D. 2018	AST	TT	FT	0	3	3	Aff. M. ASCE, Earth Retaining Structures and Earthquake Engineering and Soil Dynamics Technical Committee	H	M	L
Cresten Mansfeldt	Ph.D. 2013	AST	TT	FT	5	4	4	Engineer in Training	H	H	L
Sheldon Masters	Ph.D. 2015	AST	TT	FT	6	2	2	Future Professoriate Certificate	H	M	M
Diane McKnight	Ph.D. 1979	P	T	FT	17	27	26	N/A	H	M	L
Keith Molenaar	Ph.D. 1997	P	T	FT	7	26	26	Design-Build Certified Professional, Fellow	M	M	L
Matthew Morris	M.S. 2022	I	NTT	FT	13	11	11	Professional Engineer	L	M	H
Roseanna Neupauer	Ph.D. 2000	P	T	FT	22	21	18	Professional Engineer	H	M	H
Ronald Pak	Ph.D. 1984	P	T	FT	1	38	38	N/A	L	L	L
Tad Pfeffer	Ph.D. 1987	P	T	FT	0	35	35	N/A	H	M	L
Keith Porter	Ph.D. 2000	A	NTT	PT	16	16	16	Professional Engineer	H	H	H
Fatemeh Pourahmadian	Ph.D. 2016	AST	TT	FT	0	6	6	N/A	H	H	L

Richard Regueiro	Ph.D. 1998	P	T	FT	7	20	18	N/A	M	L	L
Fernando Rosario-Ortiz	Ph.D. 2006	P	T	FT	4	15	15	N/A	H	H	M
Joseph Ryan	Ph.D. 1992	P	T	FT	2	29	29	N/A	M	L	M
Carlo Salvinelli	Ph.D. 2016	I	NTT	FT	6	9	3	N/A	M	M	L
Victor Saouma	Ph.D. 1980	P	T	FT	2	40	40	N/A	M	L	M
Jennifer Scheib	M.S. 2004	AST	NTT	FT	13	6	6	LEED AP	H	H	L
Christopher Senseney	Ph.D. 2011	ASC	NTT	FT	12	9	3	Professional Engineer NCEES	H	H	M
Jeong-Hoon Song	Ph.D. 2008	ASC	T	FT	0	12	9	N/A	H	M	L
Wil Srubar	Ph.D. 2013	ASC	TT	FT	2	10	10	Engineer in Training, LEED AP	H	H	H
Anthony Straub	Ph.D. 2017	AST	TT	FT	0	4	4	N/A	L	L	L
Evan Thomas	Ph.D. 2009	P	T	FT	19	13	5	PE, State of Texas	M	H	H
Cristina Torres-Machi	Ph.D. 2015	AST	TT	FT	4	12	6	N/A	L	M	H
Sandra Vasconez	M.A. 2000	AST	NTT	FT	13	20	16	NCQLP Lighting Cert.	M	M	M
Bradley Wham	Ph.D. 2015	AST	NTT	FT	1	6	6	EIT	H	M	H
Yunping Xi	Ph.D. 1991	P	T	FT	4	30	26	N/A	H	M	L
Edith Zagona	Ph.D. 1992	P	NTT	FT	10	5	35	Registered PE (for 30 years but now lapsed)	M	H	H
John Zhai	Ph.D. 2003	P	T	FT	1	20	20	N/A	H	M	L
Yida Zhang	Ph.D. 2016	AST	TT	FT	0	7	7	N/A	H	H	L
Wangda Zuo	Ph.D. 2010	ASC	TT	FT	3	10	6	N/A	H	L	L

1. Code: P = Professor ASC = Associate Professor AST = Assistant Professor I = Instructor A = Adjunct O = Other
2. Code: T = Tenured TT = Tenure Track NTT = Non-Tenure Track
3. FT = Full-Time Faculty or PT = Part-Time Faculty
4. The level of activity (high, medium or low) should reflect an average over the three years prior to the visit.

Table 6-2. Faculty Workload Summary

Civil and Architectural Engineering

Faculty Member (name)	PT or FT ¹	Classes Taught (Course No./Credit Hrs.) Term and Year ²	Program Activity Distribution ³			% of Time Devoted to the Program ⁵
			Teaching	Research or Scholarship	Other ⁴	
Amadei, Bernard	FT	CVEN 4157, A Systems Approach to Global Engineering, 3 Credit, S 23 CVEN 5157, A Systems Approach to Global Engineering, 3 Credit, S 23	25	35	40	10
Archart, Jay	FT	AREN 1316, Intro to Architectural Engineering, 1 Credit, F 22 AREN 4080, Architectural Design Studio 2, 2 Credits, F 22 AREN 4830, Special Topic: Sustainable Building Design, 3 Credits, F 22 AREN 3080, Architectural Design Studio 1, 3 Credit, S 23 AREN 4318, Senior Design 1, 5 credits, F 22 AREN 4319, Senior Design 2, 2 Credits, S 23 AREN 4890, Sustainable Building Design, 3 Credit, S 23 AREN 5890, Sustainable Building Design, 3 Credits, S 23	80	0	20	100
Baker, Kyri	FT	AREN 5001, Building Energy Systems 1, 3 Credits, F22 CVEN 5830, Special Topics: Grid Connected Systems, 3 Credits, F22 AREN 3040, Circuits for Architectural Engineers, 3 Credit, S 23 AREN 4319, Senior Design 2, 2 Credit, S 23	30	40	30	100
Balaji, Rajagopalan, Former Department Chair	FT	CVEN 6393, Hydrologic Sciences and Water Resources Engineering, 3 Credits, F 22 CVEN 5454, Statistical Methods for NATural and Engineered Systems, 3 Credit, S 23 CVEN 6393, Hydrologic Sciences and Water Resources Engineering, 3 Credit, S 23	25	25	50	5
Becker, William	PT	CVEN 5594, Water Reuse and Reclamation, 3 Credit, F 22 CVEN 4434, Environmental Engineering Design, 3 Credit, S 23	60	10	30	20
Bhaskar, Aditi	FT	CVEN 4833, Special Topic: Analysis of Urban Water Systems, 3 Credit, S 23	40	40	20	5

Faculty Member (name)	PT or FT ¹	Classes Taught (Course No./Credit Hrs.) Term and Year ²	Program Activity Distribution ³			% of Time Devoted to the Program ⁵
			Teaching	Research or Scholarship	Other ⁴	
		CVEN 5833, Analysis of Urban Water Systems, 3 Credit, S 23				
Bielefeldt, Angela	FT	CVEN 1317, Intro to Civil and Environmental Engineering, 1 Credit, F 22	30	40	30	20
Bolhari, Azadeh	FT	CVEN 4404, Water Chemistry, 3 Credit, F 22 CVEN 4414, Water Chemistry Lab, 3 Credit, F 22 EVEN 4494, Contaminant Fate and Transport, 3 Credit, F 22 CVEN 4434, Environmental Engineering Design, 3 Credit, S 23	70	10	20	20
Celoza, Amelia	FT	AREN 2050, Building Materials and Systems, 3 Credits, F 22 CVEN 5836, Special Topic: Program and Project Management, 3 Credit, S 23	40	40	20	50
Cook, Sherri	FT	Maternity Leave, F 22 Course Buy-Out, S23	40	40	20	20
Crimaldi, John	FT	CVEN 5313, Environmental Fluid Mechanics 3 Credits, F 22 CVEN 5343, Transport and Dispersion in Surface Water, 3 Credit, S 23	10	80	10	5
Dashti, Shideh, Interim Associate Dean of Research, College of Engineering and Applied Sciences	FT	CVEN 3708, Geotechnical Engineering 1, 3 Credit, F 22 <i>Teaching Buy-Out Due to Deanship</i>	10	15	75	10
Gooseff, Michael	FT	CVEN 3313, Theoretical Fluid Mechanics, 3 Credit, S 23 CVEN 5833, Surface-Groundwater Exchanges, 3 Credit, S 23	25	80	15	5
Hallowell, Matthew	FT	Sabbatical, F 22 Sabbatical, S 23	15	65	20	50
Hearn, George	FT	CVEN 4555, Reinforced Concrete Design, 3 Credit, F 22 CVEN 5575, Advanced Topics in Steel Design, 3 Credits, F 22 CVEN 5333, Physical Hydrology, 3 Credits, F 22 CVEN 4545, Steel Design, 3 Credit, S 23	53	27	20	50

Faculty Member (name)	PT or FT ¹	Classes Taught (Course No./Credit Hrs.) Term and Year ²	Program Activity Distribution ³			% of Time Devoted to the Program ⁵
			Teaching	Research or Scholarship	Other ⁴	
		CVEN 5585, Advanced Topics in Reinforced Concrete Design, 3 Credit, S 23				
Henze, Gregor	FT	AREN 2110, Thermodynamics, 3 Credits, F 22 AREN 4110, HVAC System Design, 3 Credit, S 23 AREN 5110, HVAC System Design, 3 Credits, S 23	25	60	15	100
Hernandez, Mark	FT	Sabbatical, F 22 Sabbatical, S 23	10	80	10	20
Hubler, Mija	FT	Sabbatical, F 22 Sabbatical, S 23	10	80	10	50
Javernick-Will, Amy	FT	AREN 4506, Pre-Construction Estimating and Scheduling, 3 Credit, S 23 CVEN 5346, Managing Construction and Engineering Projects and Orgs, 3 Credit, S 23	30	50	20	50
Kuchenrither, Richard	PT	CVEN 5564, Water Profession: Communication and Utility Finance,, 3 Credit, S 23	60	0	40	5
Kasprzyk, Joseph	FT	CVEN 5423, Water Resources Engineering Design, 3 Credits, F 22 CVEN 5393, Water Resources System Management, 3 Credit, S 23	25	60	15	5
Klees, Rita	FT	CVEN 5939, Global Development Practicum, 3 Credit, S 23	80	0	20	5
Korak, Julie	FT	CVEN 4464, Environmental Engineering Process, 3 Credit, F 22 EVEN 5444, Analytical Methods, Experimental Design, and Applied Data Analysis, 3 Credit, S 23 EVEN 5830, Special Topic, 3 Credit, S 23	40	40	20	20
Krarti, Moncef	FT	AREN 4570, Electrical Systems for Buildings, 3 Credits, F 22	25	60	15	100
Liel, Abbie	FT	Sabbatical, F 22 Sabbatical, S 23	25	60	15	50
Linden, Karl Department Chair	FT	Sabbatical, F 22	10	80	10	20
Livneh, Ben	FT	Sabbatical, F 22 Sabbatical, S 23	40	40	20	5
Madabhushi, Srikanth	FT	CVEN 3718, Geotechnical Engineering 2, 3 Credit, F 22	40	40	20	10

Faculty Member (name)	PT or FT ¹	Classes Taught (Course No./Credit Hrs.) Term and Year ²	Program Activity Distribution ³			% of Time Devoted to the Program ⁵
			Teaching	Research or Scholarship	Other ⁴	
		CVEN 4728, Foundation Engineering, 3 Credit, S 23 CVEN 5728, Foundation Engineering, 3 Credit, S 23				
Mansfeldt, Cresten	FT	CVEN 4484, Intro to Environmental Microbiology, 3 Credit, S 23	40	40	20	20
Masters, Sheldon	FT	CVEN 3414, Fundamentals of Environmental Engineering, 3 Credit, F 22	40	40	20	20
McKnight, Diane	FT	CVEN 5323, Applied Stream Ecology, 3 Credits, F 22 CVEN 3434, Intro to Applied Ecology, 3 Credit, S 23	40	40	20	5
Molenaar, Keith Dean of the College of Engineering and Applied Sciences	FT	<i>Teaching Buy-out Due to Deanship</i>	10	15	75	50
Morris, Matthew	FT	CVEN 3246, Intro to Construction, 3 Credit, F 22, S 23 CVEN 5006, Construction Engineering and Management Fundamentals, 3 Credits, F 22 AREN 4606, Construction Project Execution and Control, 3 Credit, S 23 CVEN 4899, Senior Project, 3 Credit, S 23	70	0	30	50
Neupauer, Roseanna	FT	CVEN 3323, Hydraulic Engineering, 3 Credit, F 22 CVEN 4353, Groundwater Engineering, 3 Credit, F 22 CVEN 5353, Groundwater Hydrology, 3 Credits, F 22	35	40	25	5
Pak, Ronald	FT	CVEN 5798, Dynamics of Soil and Structure, 3 Credits, F22 CVEN 3708, Geotechnical Engineering 1, 3 Credit, S 23 CVEN 5131, Continuum Mechanics and Elasticity, 3 Credit, S 23	40	40	20	10
Pfeffer, William (Tad)	FT	CVEN 2012, Intro to Geomatics, 3 Credit, F 22	40	20	40	10
Pourahmadian, Fatemah	FT	CVEN 5111, Structural Dynamics, 3 Credits, F 22 CVEN 3111, Analytical Mechanics 2, 3 Credit, S 23 CVEN 5151, Wave Methods for Design and Characterization of Advanced Materials, 3 Credit, S 23	40	40	20	10
Regueiro, Richard	FT	CVEN 5537, Numerical Methods in Civil Engineering, 3 Credits, F 22 CVEN 7511, Computational Finite Inelasticity and Multiphase Mechanics, 3 Credits, F 22	30	40	30	10

Faculty Member (name)	PT or FT ¹	Classes Taught (Course No./Credit Hrs.) Term and Year ²	Program Activity Distribution ³			% of Time Devoted to the Program ⁵
			Teaching	Research or Scholarship	Other ⁴	
		CVEN 4899, Senior Project Design, 3 Credit, S 23				
Rosario-Ortiz, Fernando Associate Dean of Faculty, College of Engineering and Applied Sciences	FT	<i>Teaching Buy-out Due to Deanship</i>	10	15	75	20
Ryan, Joseph	FT	CVEN 4424, Environmental Organic Chemistry, 3 Credit, S 23	30	30	40	20
Salvinelli, Carlo	FT	EVEN 4830, Special Topic: Applied Global Engineering, 3 Credit, F 22 EVEN 2004, Intro to Global Engineering, 3 Credit, F 22 CVEN 5830, Intro to Humanitarian Aid, Disaster Risk Reduction, 3 Credit, F 22 EVEN 5999, Refugees and Displacement, 3 Credit, F 22 CVEN 5837, Special Topic: Study Design and Impact Eval, Community Appraisal 3 Credit, S 23	65	25	10	20
Saouma, Victor	FT	CVEN 5525, Matrix Structural Analysis, 3 Credits, F 22 CVEN 4525, Matrix Structural Analysis, 3 Credit, F 22	40	40	20	50
Scheib, Jennifer	FT	AREN 4620, Adaptive Lighting Systems, 3 Credits, F 22 AREN 5001, Building Energy Systems: Thermal, Electrical, and Lighting Systems, 3 Credits, F 22 AREN 5620, Adaptive Lighting Systems, 3 Credits, F 22 AREN 5580, Daylighting, 3 Credits, S 23 AREN 3080, Architectural Design Studio 1, 3 Credit, S 23 AREN 3540, Illumination 1, 3 Credit, S 23 AREN 4580, Daylighting, 3 Credit, S 23	80	0	20	100
Senseney, Christopher	FT	CVEN 2012, Intro to Geomatics, 3 Credit, F 22, S 23 AREN 4318, Senior Design 1, 3 Credits, F 22 CVEN 3256, Construction Equipment and Methods, 3 Credit, F 22 AREN 4319, Senior Design 2, 2 Credit, S 23 GEEN 1400, Engineering Projects, 3 Credit, S 23	70	10	20	50
Song, Jeong-Hoon	FT	CVEN 2121, Analytical Mechanics 1, 3 Credit, S 23 CVEN 3525, Structural Analysis, 3 Credit, S 23	10	80	10	50
Srubar, Wil V.	FT	AREN 5830, Building Energy Systems 2, 3 Credits, F 22 CVEN 4565, Design of Wood Structures, 3 Credit, S 23	25	60	15	100

Faculty Member (name)	PT or FT ¹	Classes Taught (Course No./Credit Hrs.) Term and Year ²	Program Activity Distribution ³			% of Time Devoted to the Program ⁵
			Teaching	Research or Scholarship	Other ⁴	
		CVEN 5835, Special Topic: Design of Wood Structures, 3 Credit, S 23				
Straub, Anthony	FT	CVEN 3414, Fundamentals of Environmental Engineering, 3 Credit, S 23	40	40	20	50
Thomas, Evan	FT	EVEN 4830, Special Topic: Applied Global Engineering, 3 Credit, F 22 EVEN 2004, Intro to Global Engineering, 3 Credit, F 22 CVEN 5838, Special Topic: Intro to Global Health for Engineers, 3 Credit, S 23	15	40	45	20
Torres-Machi, Cristina	FT	CVEN 3602, Transportation Systems, 3 Credit, F 22 CVEN 5836, Special Topics: Infrastructure Asset Management, 3 Credits, F 22 CVEN 3227, Probability, Statistics, and Decision for CVEN, 3 Credit, S 23	40	40	20	50
Vasconez, Sandra	FT	AREN 4830, Special Topic: Architectural Lighting Design, 3 Credits, F 20 AREN 4530, Advanced Lighting Design, 3 Credits, F 22, S23 AREN 4550, Illumination 2, 3 Credits, F 22 AREN 5830, Special Topic: Advanced Lighting Design, 3 Credits, F 22, S 23 AREN 3430, Architectural (Interior) Lighting Design, 3 Credit, S 23 AREN 4319, Senior Design 2, 2 Credit, S 23 CVEN 4837, Outdoor Lighting, 3 Credit, S 23	70	0	30	100
Xi, Yunping	FT	CVEN 4161, Mechanics of Materials 2, 3 Credit, F 22 CVEN 5831, Special Topic: Advanced Construction Materials, 3 Credits, F 22 CVEN 5161, Advanced Mechanics of Materials, 3 Credits, F 22 CVEN 3161, Mechanics of Materials 1, 3 Credit, S 23	40	40	20	50
Zhai, Zhiqiang (John)	FT	AREN 3010, Energy Efficient Buildings, 3 Credits, F 22 AREN 5830, Building Energy Systems 2, 3 Credits, F 22 AREN 2120, Fluid Mechanics and Heat Transfer, 3 Credit, S 23 AREN 2121, Heat Transfer, 1 Credit, S 23	40	40	20	100

Faculty Member (name)	PT or FT ¹	Classes Taught (Course No./Credit Hrs.) Term and Year ²	Program Activity Distribution ³			% of Time Devoted to the Program ⁵
			Teaching	Research or Scholarship	Other ⁴	
Zhang, Yida	FT	CVEN 5708, Soil Mechanics, 3 Credits, F 22 CVEN 3718, Geotechnical Engineering 2, 3 Credit, S 23 CVEN 7718, Engineering Properties of Soil, 3 Credit, S 23	40	40	20	10

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. Most faculty are less than 100% to the Civil Engineering program due to time devoted to Architectural Engineering (AREN) or Environmental Engineering (EVEN) students via course instruction and/or advising.

CRITERION 7. FACILITIES

A. Offices, Classrooms and Laboratories

1. Offices (such as administrative, faculty, clerical, and teaching assistants) and any associated equipment that is typically available there. The administrative office for the Department of Civil, Environmental, and Architectural Engineering is located on the 4th floor of the Engineering Center. Four faculty groups (building systems, geotechnical engineering, structural engineering, construction engineering and management) have offices on the 2nd, 4th, and 5th floor of the Engineering Center. Two faculty groups (water resources, environmental engineering) have offices in the Sustainability, Energy, and Environment Complex (SEEC) on East Campus. The department has made four desks in offices on the 4th floor of the Engineering Center available for hoteling for faculty with offices on East Campus so that they can hold office hours on Main Campus. Teaching Assistants have offices on the 2nd, 1st, and Basement levels of the Engineering Center. All staff have offices on the 1st or 4th floor of the Engineering Center.
2. Classrooms and associated equipment that are typically available where the program courses are taught. The majority of courses are taught in the Engineering Center, 1111 Engineering Drive, ECOT 441 UCB 428, Boulder, Colorado 80309. Classrooms in the Engineering Center Civil Engineering (ECCE) wing, the Engineering Center Classroom (ECCR), and Engineering Center Computer Science (ECCS) wing are used by the department. A few courses are taught in the adjacent Koebel (KOBL) business school building, as well as the Fleming (FLEM) building and the new Center for Academic Success and Engagement (CASE) building.
3. Laboratory facilities used by CVEN Students primarily include the Center for Infrastructure, Energy, and Space Testing (CIEST) Laboratory. The CIEST Laboratory includes the laboratory classrooms and equipment students use for structural engineering and geotechnical engineering courses (e.g., CVEN 3161 Mechanics of Materials). See **Accreditation Policies and Procedures Manual** for the comprehensive laboratory and safety manual of this facility.

Engineering Center

The Engineering Center comprises over 600,000 square feet of classrooms, computing facilities, faculty offices, and research laboratories. This includes facilities on central campus, the SEEC (Sustainability, Energy and Environmental Complex) building, the SEEL (Sustainable Energy and Environmental Laboratories) building, the Jennie Smoly Caruthers Biotechnology Building, and the Aerospace Building. These buildings also house centrally-scheduled classrooms, which are used heavily for engineering classes (but not exclusively) and open computer labs, available to all students. Working with the campus OIT organization, the College ensures that the open computer labs are configured with software tools needed by engineering students. The Lesser House, home to the Herbst Program for Engineering, Ethics and Society, is across the street from the Engineering Center and is very accessible to engineering students.

Idea Forge

The Idea Forge, which opened during the fall of 2014 is a flexible, cross-disciplinary collaborative space where students can imagine, design, create, and test products and solutions to meet a range of societal and customer needs. The space supports student teams working on invention and innovation as part of courses, as well as design and development driven by entrepreneurial-minded individuals and service-oriented groups. With all these students working side-by-side, the Idea Forge boosts student learning through collaborative, hands-on experience, while supporting industry interaction through scheduled workshops as well as spontaneous exchanges. The Idea Forge space resources that support the design curriculum include the following (pictures are available at <http://www.colorado.edu/ideaforge/facilities>):

- Idea Forge Commons: The Commons, the figurehead space within the Idea Forge, provides students with an open, spacious area for ideation and brainstorming as well as worktables for project work.
- Project-Based Learning Studio: a classroom completely dedicated to learning through hands-on experience. With its round tables, the room holds classes that focus on teamwork and small group discussion rather than lecture. There are many dry-erase boards on wheels to use for breakout sessions, general group work, or dividing the room into multiple sections.
- Drop-In Design Lab: The space holds a SolidWorks CAD computer lab and plenty of project work space. There are two study rooms available for students to reserve.
- Chevron Design Studio: The Chevron Design Studio is a large design and build space run by Design Center Colorado and dedicated to the Mechanical Engineering Senior Design class. This course allows students to work on industry sponsored projects while guided by a faculty advisor.
- Micro-Motion Thinking Lab: Break Space

Integrated Teaching and Learning Laboratory

The Integrated Teaching and Learning (ITL) Program at the University of Colorado Boulder is a nationally recognized award-winning engineering education leader. The ITL Program supports hands-on engineering learning through an innovated environment where students integrate engineering theory with practice and learn through doing.

The Integrated Teaching and Learning Laboratory (ITLL) is a state-of-the-art facility that provides 34,400 square feet of space for students to engage in hands-on design activities, including a learning plaza that facilitates interdisciplinary, team-based projects, along with manufacturing, fabrication, and electronics centers where students can create projects for their engineering courses or extracurricular learning pursuits. The architecture of this facility was driven entirely by curricular reform initiatives focused on increasing student learning and engagement through the integration of design-based learning into the curriculum.

The ITLL hosts the First Year Engineering Projects course and 10-20 other Mechanical Engineering courses each academic year. These courses range from required sophomore and junior level courses such as Statics, Structures, Thermodynamics, and Fluids, to senior and graduate level electives such as Bioinspired Robotics and Flow Visualization.

Engineering students have access to five teaching spaces within the ITLL. Two design studios dedicated to the First-Year Engineering Projects course where they experience the engineering design process in a hands-on way, two large lab plazas where faculty can lecture while students have direct access to computers and test equipment, and one active learning classroom where faculty host lecture-based courses.

Engineering students in any engineering course have access to a full suite of fabrication resources as detailed below:

- The manufacturing center provides students with access to a wide range of computer guided and manual equipment used to fabricate project components out of wood, plastic, and metal. The available equipment includes hand tools, saws, drills, manual mills and lathes, CNC Lathes, a 3-axis CNC mill and a 5-axis CNC mill.
- The electronic center allows students to learn how to solder and prototype basic electronic circuits.
- The electronics fabrication center allows students to design, fabricate and assemble custom printed circuit boards.
- The fabrication station includes a wide range of tools used for prototyping and fabrication including ten 3D printers, four laser cutters, and two sewing machines.

The ITLL has 115 computers dedicated to students with a myriad of software available for use. Commonly used software includes Ansys, Arduino IDE, Blender, Digilent Waveforms, EES, Labview, MATLAB, and SolidWorks (full list available at <https://itll.colorado.edu/software/>). The two lab plazas in the ITLL have 76 fixed lab stations equipped with computers with dual monitors, data acquisition systems, external power supplies, multimeters, wave form generators, and oscilloscopes. The lab plazas are used extensively by ME students enrolled in upper-division classes including Circuits & Electronics, Data Analysis & Experimental Methods, and System Dynamics.

The ITLL also manages an inventory of over 3000 commonly used items for students to check out. Examples include laptops for students to complete testing offsite, sensors and actuators for use in projects and course work, and electronics development kits so students can prototype electronics before needing to purchase items themselves.

Each workstation has the following:

2x Desktop Power Supplies
1x Function Generator
1x Desktop Multi Meter
1x Oscilloscope

Total workstations in the building:

1B10 – 39 workstations
2B10 – 37 workstations
ECCE 167 – 6 workstations
ECCE 168 – 6 workstations
Checkout equipment – 5 workstations

Total equipment:

186x Desktop Power Supplies
93x Function Generator
93x Desktop Multi Meter
93x Oscilloscope

Additional Classrooms and Learning Spaces

Students, faculty, and staff have access to a variety of technology enhanced learning spaces. OIT (Office of Information Technology) maintains over 500 technology-equipped classrooms campus wide, which includes most (but not all) College of Engineering and Applied Science's classrooms. Each technology-equipped classroom and lecture hall contains at minimum a video display (LCD or Data Projector), audio reinforcement, and wireless networking capability. This includes 44 classroom capture equipped classrooms and over 300 hybrid capable classrooms. Classroom sizes range from 12 to 375 seats. Most classrooms on campus have an audience response system, CU iClicker.

Room types and features:

- Media Equipped Classrooms (ME): Includes LCD TV monitor with cables to display laptop content, but no DVD Player.
- Smart Classrooms (SC): Contains a data projector or monitor, a projection screen, a sound system, and a DVD/CD Player (unless noted otherwise).
- Active Learning Rooms (ALR) : Features furniture allowing students to face each other, supporting small-group work. Tables are often paired with whiteboards and large LCD displays. Instructors can choose a table's work to share with the entire class.
- Large Lecture Halls (LLH): Same functionality as Smart Classrooms with larger capacity. Some have multiple projector setup, all have voice reinforcement and classroom capture. Supports Hybrid Instruction
- Remote-Capable Classroom (RCC): CU Boulder's new Remote-Capable Classroom (RCC) Service is a hybrid teaching solution which allows for synchronous (real-time) and asynchronous (on-demand) lecture and presentation delivery. The RCC Service provides instructors with a simple technology solution, a Crestron Mercury X system, that enables the simultaneous delivery of lectures to students that are physically in the classroom as well as students working remotely.
- Classroom Capture (CC): Capture audio and video from lectures or special events then make available online for on-demand viewing. [Learn more about Classroom Capture](#). Supports Hybrid Instruction.
- Classroom Capture Plus (CC+): Offers the same functionality of standard Classroom Capture spaces with the addition of audience microphones to record audience participation. Supports Hybrid instruction.
- CUClickers Receivers (CR): Classrooms with a capacity of over 40 have an iClicker receiver in the media cabinet.
- Wireless Microphones (WM): Some larger classrooms on campus have wireless microphones.
- Computing Labs (LAB): OIT managed student computing labs contain varied configurations of workstations.

Building	Room	Features	Capacity
ENGINEERING CENTER	ECCE 141 CAD	Windows LAB, SC, RCC, CR, WM	48
ENGINEERING CENTER	ECCE 1B41	SC, CC+, CR, WM - No DVD Player	49
ENGINEERING CENTER	ECCR 105	SC, CC+, CR, WM - No DVD Player	68
ENGINEERING CENTER	ECCR 108	SC, RCC, CR	28
ENGINEERING CENTER	ECCR 110	SC, RCC, CR	27
ENGINEERING CENTER	ECCR 116	SC, RCC, CR	27
ENGINEERING CENTER	ECCR 118	SC, RCC, CR	27
ENGINEERING CENTER	ECCR 131	SC, RCC, CR	28
ENGINEERING CENTER	ECCR 135	SC, RCC, CR	47
ENGINEERING CENTER	ECCR 139	SC, RCC, CR	29
ENGINEERING CENTER	ECCR 143	Windows LAB, SC, CR	26
ENGINEERING CENTER	ECCR 150	SC, CC+, CR, WM - No DVD Player	64

ENGINEERING CENTER	ECCR 151	SC, RCC, CR, WM	48
ENGINEERING CENTER	ECCR 155	SC, RCC, CR, WM	48
ENGINEERING CENTER	ECCR 1B08	SC, RCC, CR	20
ENGINEERING CENTER	ECCR 1B40	SC, RCC, CR, WM	138
ENGINEERING CENTER	ECCR 1B51	SC, CC+, CR, WM - No DVD Player	48
ENGINEERING CENTER	ECCR 1B55	SC, CC+, CR, WM - No DVD Player	48
ENGINEERING CENTER	ECCR 200	SC, CC, CR, WM	106
ENGINEERING CENTER	ECCR 245	SC, RCC, CR, WM	106
ENGINEERING CENTER	ECCR 265	SC, RCC, CR, WM	152
ENGINEERING CENTER	ECCS 1B12	SC, CC+, CR, WM - No DVD Player	94
ENGINEERING CENTER	ECCS 1B14	SC, CC+, CR, WM - No DVD Player	30
ENGINEERING CENTER	ECCS 1B28	SC, CC+, CR, WM - No DVD Player	78
ENGINEERING CENTER	ECCS 201	LLH, CC, CR, WM	191

ENGINEERING CENTER	ECST 1B21	SC, RCC, CR	20
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Blow Things Up (BTU) Lab

The ATLAS BTU Lab is a hackerspace and maker community situated on the first floor of the Roser ATLAS Building (ATLS 113). The lab is operated by the ATLAS Institute and it is **open to all CU Boulder students**, regardless of department or field of study. The BTU will have separate access to two areas: the BTU Lab work area and classroom (ATLS Rm 113 and 113A), and the BTU Tool Room (ATLS 105). Members of the BTU Lab have access to a wide range of tools and fabrication equipment, including 3D printers, a laser cutter, woodworking tools, electronic equipment and more.

SEEC

The Environmental Engineering program recently joined numerous other sustainability programs, institutes and agencies in the Sustainability, Energy and Environment Complex (SEEC) on CU Boulder's East Campus. The building is a national hub for learning, research and innovation in environmental sustainability designed to spur collaboration on global energy and environmental challenges. All the classrooms, offices, labs, equipment, and facilities that are housed within university buildings conform to standard fire, safety, building, and health codes.

JSCBB

The Jennie Smoly Caruthers Biotechnology Building is a 330,000 square foot research and teaching facility. It houses faculty, staff and students from the Biofrontiers Institute, the department of Chemical and Biological Engineering, and the Division of Biochemistry

Aerospace Building

The Aerospace Engineering Sciences building opened in 2019. At nearly 180,000 square feet, the building features world-class learning spaces for the department's signature hands-on experiential learning curriculum. It also features laboratories for testing autonomous aircraft and ground vehicles, studying aerodynamics, structures and materials, and houses a *Dream Chaser* spacecraft cockpit module provided by Sierra Nevada Corp. used for human factors and human-machine interaction studies as part of the department's broader research into next generation human spaceflight systems. Students and faculty here also conduct groundbreaking Earth and space sciences research, learning about everything from the ocean to the solar wind and more.

Engineering Space Assessment by Unit- 2016 Data																			Total (sq ft)
Space Type	Admin	AES ₁	ChBE	CEAE ₂	CS	ECEE	ME	ATLAS	GEEN	ITL	IDEA FORGE	BOLD	HERBST	EMP	ITP	CSGC	CNL	NCF	
Office*	20,705	18,722	21,384	25,352	12,012	26,105	21,749	8,378	390	7,939	3,647	3,112	2,146	1,371	2,692	603	131	162	176,600
Instructional	680	9,341	4,495	10,962	2,770	11,130	6,977	13,101	0	15,664	8,495	0	291	0	2,213	2,840	0	0	88,959
Research	0	32,670	30,627	35,255	13,387	30,644	29,148	0	0	191	2,689	0	0	0	780	0	4,175	1,524	181,090
Totals	21,385	60,732	56,506	71,569	28,169	67,879	57,874	21,479	390	23,794	14,831	3,112	2,437	1,371	5,685	3,443	4,306	1,686	446,648

¹ Includes: Aerospace Engineering, Astrodynamics Research, Center for Aerospace Structures, Bioserve Space Technologies & RECUV

² Includes: Civil Engineering, Environmental Engineering & CADSWES

* Includes all central storage (except ECEE 2B75)

Space Type	CEAS	AES ₁	ChBE	CEAE ₂	CS	ECEE	ME	ATLAS	UGRAD Programs	GRAD Programs	Research Facilities	Total (sq ft)						
Office*	23,817	18,722	21,384	25,352	12,012	26,105	21,749	8,378	14,725	4,063	293	176,600						
Instructional	680	9,341	4,495	10,962	2,770	11,130	6,977	13,101	27,290	2,213	0	88,959						
Research	0	32,670	30,627	35,255	13,387	30,644	29,148	0	2,880	780	5,699	181,090						
Totals	24,497	60,732	56,506	71,569	28,169	67,879	57,874	21,479	44,895	7,056	5,992	446,648						

B. Computing Resources

Campus-wide/Institutional Computing Resources

The majority of campus-wide computing resources are provided by the Office of Information Technology (OIT), which provides CU-Boulder with innovative, customer-focused IT support and core IT services. Under the leadership of the Office of the Senior Associate Vice Chancellor for IT and CIO, OIT partners and collaborates with academic, research, and administrative units in order to create a robust, best-in-class IT environment.

Computing resources are provided by OIT as well as colleges, departments, institutes, centers, etc. OIT provides coordinated, centralized IT support as well as core IT services in areas such as academic technologies, communication technologies, enterprise IT services, infrastructure, Research Computing and IT security.

Networking

The University of Colorado has a robust, enterprise-level network that serves both wired and wireless Internet access to nearly every corner of the campus, as well as providing VPN opportunities for off-campus connections.

1. Wired connectivity – 1 Gigabit/secs Ethernet, 13 distribution routers, 700 switches, servicing ~50,000 hardwire attached devices
2. Wireless connectivity – 802.11a/b/g/n/ac/ax, 100,000+ registered wireless devices, 8,800+ access points
3. VPN connectivity
4. Institutional network backbone – 100 Gigabit/sec Ethernet Distribution to Switch Edge. 90 Gigabit/sec aggregate Internet (2x40 Gbps; 1x10 Gbps) connectivity.
5. ScienceDMZ –800 GigaBit/sec core with no firewalls and 90 Gigabit/sec Internet connectivity managed jointly by Research Computing and OIT networking

Cloud Computing

CEAS Cloud Computing is an online lab environment administrated by the Integrated Teaching and Learning Program, providing students within the College of Engineering and Applied Science access to educational software anywhere in the world since August 2020. This environment includes software such as AutoCAD, ANSYS, EES, LabVIEW, MATLAB, Solidworks and dozens more (full list available at <https://www.colorado.edu/engineering/cloudcomputing>) that are fully pre-configured for quick and easy use. Different virtual hardware options allow students to select from desktops geared toward computational needs as well as those who need dedicated graphics hardware regardless of the hardware specifications of their personal computing device. Using the scalability afforded by cloud services, the capacity of this system can be increased or decreased, as needed, throughout the day to support our student population.” Computer Labs

There are thirty-six centrally-managed labs on campus. The University maintains a three- or four-year hardware replacement schedule for most workstations. Software on the machines is upgraded every semester with new or updated versions of important Engineering software packages. The hours of availability and access vary according to the policies of individual buildings and departments. However, most Engineering labs are open at all hours for students in the College of Engineering.

There are eight centrally-managed labs in the Engineering complex. These labs are configured with similar workstation hardware and software in all locations. Current configurations and software availability can be found on the OIT website: <https://keyserver.colorado.edu/software> (VPN access is required if off campus).

The following engineering-related software is installed on most computers:

A variety of software compilers	MATLAB
Abaqus	Maple
Alteryx Designer	Minitab
ANSYS	MPlus
ArcGIS	MVPstats
AspenONE Suite	OriginPro
AutoCAD Suite	Praat
COMSOL	R/R Studio
EES (Engineering Equation Solver)	Revit
ENVI	SAS
EQS	Schedule and Super Pro
IDL	SPSS
JMP PRO	SolidWorks
LabVIEW	TeXworks
Mathcad Prime	
Mathematica	

Academic Technologies

Besides ubiquitous Internet connectivity and laboratory space, students are provided with many other computing services and software to support their learning needs. Teaching and learning technologies provided and supported by [the Office of Information Technology](#) (OIT) at CU Boulder include learning management system Canvas, audience response system CUClickers, lecture capture tool Classroom Capture, in-video questions software PlayPosit, remote proctoring service Proctorio, and video conferencing tool Zoom. OIT strives to provide a unified digital experience for students and integrates all [the standalone learning tools with the learning management system](#) to achieve the unified experience and make transitions between tools seamless for the students. OIT also extends the learning management system integration service to learning tools not supported by the campus on a per-request basis and requires that the tools undergo CU Boulder security and accessibility compliance review initiated via the [Digital Technology Compliance Review Request \(Form A\)](#). Each campus-supported tool also undergoes accessibility review and some features are also tested by [the Digital Accessibility Office](#). The Digital Accessibility Office also provides accessibility guidelines, training, universal design consultations, and captioning service to campus constituents.

C. Guidance

The Department provides students with guidance on the use of the computing tools, resources, and labs discussed in this section through a variety of means. In courses where

students will be using laboratory facilities (e.g. Mechanics of Materials, Introduction to Geotechnical Engineering), the instructor and/or teaching assistants (TAs) describe the relevant equipment to students. Important health and safety requirements and precautions are described. Safe equipment use is monitored during the laboratory sessions by the TA and/or faculty. User guides and/or instructions for each laboratory and necessary equipment are provided to the students. The students work with the laboratory equipment during supervised laboratory times, with immediate access to teaching assistants and/or faculty to answer their questions.

The primary methods of guidance include leveraging University-wide OIT training resources, semester-length tooling courses, online and video documentation, extracurricular training sessions, and peer-tutoring. Each method is discussed in greater detail below. Many of the computer resources leveraged by the Department are provided by the University-wide Office of Information Technology (OIT). OIT provides training and guidance for such resources to students directly via their website, walk-in support desk, and phone and email support center. OIT provides a range of support service to AREN students, staff, and faculty including:

- Campus Single-Sign-On (SSO) and Directory (LDAP) Support
- OSX and Windows end-user software licensing, installation, and training
- Email, contacts, and calendaring support (Google Applications, OneDrive, and/or Microsoft Exchange)
- Classroom technology upkeep and training
- Backup services, hosted servers, etc.
- Wireless, wired, and VPN network access
- Phone (via Microsoft Teams) and related telecommunication services

Beyond the general IT support provided by OIT, the department also has a designated individual for desktop support.

D. Maintenance and Upgrading of Facilities

Larson Building Systems Laboratory

The Larson Building Systems laboratory has served the AREN program well for 40 years. To enhance the research and teaching capacity, attract students and faculty, and provide hands-on education, the laboratory underwent a >\$500K renovation to update and modernize the two roof-top commercial HVAC systems and the two reconfigurable full-scale test chambers. In order to support the ongoing maintenance of the Larson Building Systems Laboratory, the CEAE Department provides \$15,000 annually for facility maintenance.

CEAE Departmental Experimental Laboratories

The faculty who teach courses using the undergraduate teaching laboratories monitor the equipment used and generally perform basic maintenance. The department collects student fees, and the money is used to maintain, repair, and replace the laboratory equipment, when needed. The relevant course instructor simply informs the department chair of any needs, and makes the necessary purchases or contracts for needed service. Instructors can also request new equipment as they keep laboratory experiences up-to-date with current practice. Major

equipment requirements are often cost-shared between the College (via a request for funding to the Engineering Excellence Fund) and the Department.

Integrated Teaching and Learning Laboratory (ITLL)

The Integrated Teaching and Learning Laboratory (ITLL) at the University of Colorado Boulder is a nationally recognized award-winning engineering education leader. The ITLL supports hands-on engineering learning through an innovated environment where students integrate engineering theory with practice and learn through doing. Program components include a first-year design course, sophomore- and junior-level experimental hands-on learning courses, senior design projects and design expos.

OIT Controlled Computing Facilities

The computer hardware in the centrally-managed computer labs are configured to meet the high-end demands of the software specific to Engineering disciplines. The labs are outfitted with workstation-class hardware that provides the necessary CPU, memory and GPU to support these applications. The hardware is purchased with a 3-year warranty, and the machines are refreshed at the end of the three years to ensure that the labs can stay current with the demands of new and updated software. All the hardware is managed centrally using management tools like Microsoft SCCM and AppSense. These tools allow us to deploy software, manage the user environment, and monitor the security and performance of the machines. Microsoft security updates are applied weekly after-hours to ensure they do not impact the availability of the machines during classes or while students are using the machines. In addition, because these machines are used in multi-user environments, we ensure that changes made by previous users are not maintained across logins. This ensures a consistent and familiar environment for the students and faculty that use them. The machines are all configured with antivirus software to protect the students and other machines from viruses, and logins and application usage data is tracked to help us make decisions about software licensing and machine availability.

E. Library Services

The Leonard Gemmill Engineering, Mathematics & Physics Library, opened in 1992, is an 18,000 square foot facility. In the fall 2021 semester approximately 27,315 user visits were recorded. In the fall 2021 semester approximately 27,315 user visits were recorded. The library is presently open 40 hours per week and receives 25,000 – 30,000 visits per semester. Gemmill Library provides a mix of study spaces for students, including open collaborative areas where students are encouraged to meet with groups and talk, open quiet study areas where students are encouraged to keep noise to a minimum, and seven group study rooms available for students to reserve. Gemmill Library provides 22 OIT-managed computers with the general engineering software loadset for students, faculty and staff, as well as several public computers with more limited software. Printers and scanners are available in Gemmill Library. Study space and computer and printing access is available to students in the four additional Libraries that constitute University Libraries, including more extended study hours at Norlin Library which is presently open 91 hours per week

University Libraries contain vast physical collections across five campus libraries and an offsite storage facility. The Gemmill Library contains a core print monograph collection,

print periodicals, a materials collection, microform technical reports, and a popular science reading collection. Extensive electronic collections are available 24/7 and since 2019 collection development has focused on adding electronic monographs and periodicals in order to increase access. Access to online materials includes bibliographic indexes, such as Compendex and INSPEC on the Engineering Village platform and the Web of Science reference and citation database. The Libraries also subscribe to searchable full text providers, such as IEEE Electronic Library and ACM Digital Library. Additional subscriptions include technical ebook platforms like O'Reilly-Safari eBooks, AccessEngineering, Knovel Library, Springer E-Books which provide access to ebooks, reference sources, and video material. Access to standards is provided electronically from several publishers such as AIAA, ASCE, ASTM and IEEE. Standards from other publishers are purchased upon request. A comprehensive list of electronic tools and databases is available (<https://libguides.colorado.edu/az.php?a=all>). Additionally, students have access to regional and world-wide interlibrary loan services free of charge. The Libraries continually assess collection use, relevance, and needs and are highly responsive to monograph and subscription suggestions, within the constraints of the collections budget.

Research and library help is provided to students via multiple means. In Gemmill Library a team of student assistants and full time Libraries' employees, including a mix of paraprofessional and professional librarians, are available to help users with their questions about library services and finding information. In-depth research questions are referred to and answered by an engineering liaison librarian and a computer science and mathematics liaison librarian, with support from additional liaison librarians serving related disciplines (i.e. physics, chemistry, health sciences) across University Libraries. The liaison librarians answer questions via email and via one-on-one meetings, either in a library location or via Zoom. Additional research support is provided by a team of librarians who staff Ask a Librarian services in Norlin Library and on University Libraries' IM chat service.

Further, liaison librarians are available to provide in-class information literacy instruction, online tutorials, and workshops. We offer course-integrated instruction, designed around finding information resources for particular assignments or projects in a class. Workshops are also provided for co-curricular research programs. Additionally, liaison librarians create and maintain asynchronous learning materials to support learning and research for specific subjects, courses, student populations, and source formats. Instruction situates immediate student needs for skills development within a larger cognitive framework, aligned with ACRL's *Framework for Information Literacy* and the *Companion Document to the ACRL Framework for Information Literacy for Higher Education: Science, Technology, Engineering, and Mathematics*.

The Gemmill Library is committed to building an evidence-based, user-centered library. Various assessments have led to the Library reconfiguring its space to provide flexible study areas. We gather and respond to feedback from students but also attend to the larger institutional context. Liaison Librarians sit on the College's Undergraduate and Graduate Education Councils and use information gathered from those councils to help guide library decision-making. In short, this library is envisioned as one where students can access information and information professionals to support acquiring new knowledge.

F. Overall Comments on Facilities

All of the classrooms, offices, labs, equipment, and facilities that are housed within university buildings conform to standard fire, safety, building, and health codes.

The Environmental Health and Safety (EH&S) department at the University of Colorado at Boulder (<http://www.colorado.edu/ehs>) provides comprehensive environmental, health and safety services to minimize health and safety impacts to the campus and the greater Boulder community. EH&S accomplishes this through training, emergency planning, consultation and partnership with members of the campus community as well as with local, state and federal agencies. Environmental Health and Safety provides regular training programs for UCB faculty, staff and students. These classes are mandatory for those who handle, manage or come into contact with potentially hazardous materials. EH&S has a substance disposal service in which hazardous waste or expired chemicals are removed from laboratories and disposed of according to state and federal regulations, ensuring a safe laboratory environment.

Facilities Management at the University of Colorado at Boulder (<http://www.colorado.edu/facilitiesmanagement/>) further ensures a safe working environment. The Mission of Facilities Management is “To plan for and provide a physical and operational environment that supports the University of Colorado at Boulder’s mission of education, research and outreach.” One of the core values of Facilities Management is “A safe environment” and Facilities Management supports this value by providing waste removal, custodial services, pest management, recycling, the fire alarm and fire sprinkler systems, landscaping, snow removal, and safe steam and electricity generation. All of these support services contribute to the overall safety of students in the program.

The Engineering Center is generally open Monday-Thursday from 7 a.m. to 1 a.m., Friday from 7 a.m. to 10 p.m. and Saturday and Sunday 8 a.m. to 10 p.m. The Integrated Teaching and Learning Lab (ITLL) is open Monday-Thursday 7:30 a.m. to 11 p.m., Friday 7:30 a.m. to 8 p.m., and Sunday 2 p.m. to 11 p.m.

CRITERION 8. INSTITUTIONAL SUPPORT

A. Leadership

The CEAE department is the sole home for the civil engineering Bachelor's degree; it also is the sole home of the architectural engineering Bachelor's degree and supports the environmental engineering degree (which is a college-wide program with various affiliated faculty that is administratively supported by CEAE). Faculty members in the CEAE department are represented in six traditional civil/architectural engineering groups for administrative purposes:

- geotechnical (fully devoted to civil engineering),
- construction engineering & management (with equal commitment to civil and architectural engineering),
- structural engineering & mechanics (with equal commitment to civil and architectural engineering),
- water resources (committed to civil engineering, and some support environmental engineering)
- environmental (with commitment to civil and environmental engineering),
- building systems (devoted to architectural engineering)

The CEAE department has a democratic governance structure with collaborative planning and decision-making. The Department chair is elected by the faculty, with final appointment by the Dean; until now the Dean has not gone against the wishes of the faculty. The department chair is the chief administrative officer.

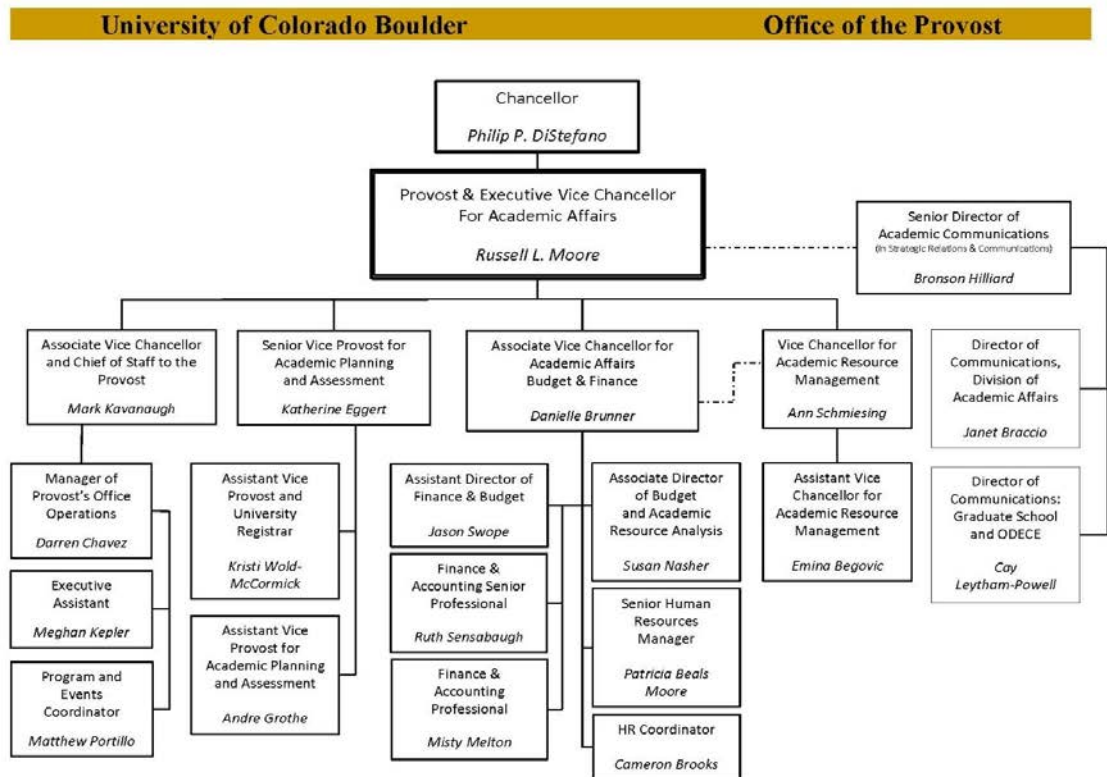
The CEAE Department is led by the Chair and the Executive Committee. Professor Balaji Rajagopalan was elected in 2014 and served until June 2022. Professor Karl Linden was elected in 2022 and is serving one 4-year term until 2026. While Professor Linden was on sabbatical in Fall 2022, Professor Rich Regueiro served as Interim Chair.

Faculty members in each sub-group nominates a member for the Executive Committee, who is then approved (or not) by a vote of the entire CEAE faculty for a three-year term. CEAE faculty are also assigned to standing committees which are considered sub-committees of the Executive Committee: Curriculum (chaired by the Associate Chair for Undergraduate Education), Graduate Recruiting & Admissions (chaired by the Associate Chair for Graduate Education), Graduate Programs & Students (P&S), Transfer, Study Abroad, and Enrichment, Undergraduate Student Pathways Committee, Facilities, Personnel (Promotion) and Operations. Ad hoc committees can be formed by the faculty to serve special purposes. Current ad hoc committees include the Justice, Equity, Diversity, and Inclusion (JEDI) Committee, Strategic Planning Committee, Mentoring Committee, Teaching Quality Framework (TQF), and Computing. Rostered instructors and research professors are voting members of the faculty and serve on the standing committees of the department, including the Executive Committee. The faculty governance structure is one of the strengths of the department. The representative structure of each sub-discipline area on the executive

committee ensures that all faculty have a voice in the direction of the program. The leadership structure is adequate to ensure the direction, continuity, and quality of the architectural engineering program.

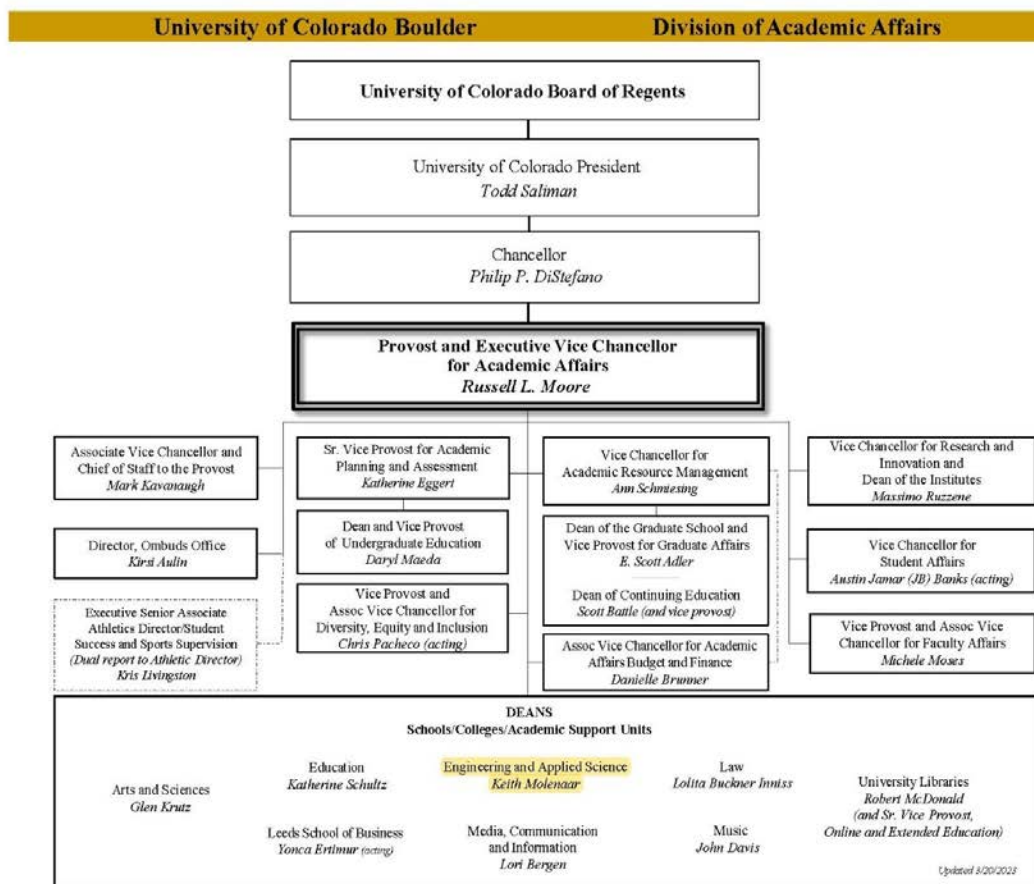
University of Colorado Boulder Leadership Organizational Charts:

Office of the Provost - https://www.colorado.edu/academicaaffairs/sites/default/files/attached-files/provosts_office_org_chart_3.16.23.pdf



3/16/2023

Academic Affairs - https://www.colorado.edu/academicaaffairs/sites/default/files/attached-files/provost_division_aa_org_chart_032023.pdf



College of Engineering and Applied Science Organizational Chart:

<https://www.colorado.edu/engineering-facultystaff/deans-office-organizational-chart>

B. Program Budget and Financial Support

The expenditures by the College of Engineering and Applied Sciences distributes the general fund budget (monies from tuition and fees, state funds, and indirect costs from grants) to the departments and programs in specific categories (ex., faculty salaries, staff salaries, TA stipends, operating funds) using well-defined formulas, established by the dean with advice from and discussion with the department chairs. These formulas are based on input data, such as enrollments, student credit hours, and research expenditures.

The Department receives its budget from the College of Engineering and Applied Science through (1) allocation of faculty positions, (2) funds to cover staff and teaching assistant salaries and operating expenses, and (3) recovery of indirect costs from grants and contracts. A portion (approximately 15%, plus 8% embedded in staff salaries) of the indirect costs recovery (ICR) from faculty's sponsored research activities is returned to the Department to augment its operating budget.

College Budget for the Department of Civil, Environmental, and Architectural Engineering						
	FY18	FY19	FY20	FY21	FY22	% Change
Salaries	\$6,005,585	\$5,961,331	\$6,062,386	\$6,526,506	\$6,316,788	5.2%
Fringe Benefits	N/A	N/A	N/A	\$2,029,196	\$1,867,328	N/A
Student Support	\$980,989	\$1,070,264	\$1,070,264	\$1,070,264	\$1,134,107	15.6%
Capital Projects	\$15,748	\$15,748	\$15,748	\$15,748	\$15,748	0.0%
Miscellaneous	\$122,737	\$122,737	\$122,737	\$122,737	\$93,196	-24.1%
Program Fees	\$139,584	\$138,315	\$136,624	\$136,216	\$135,808	-2.7%
Cont Budget Subtotal	\$7,264,643	\$7,308,395	\$7,407,759	\$9,900,667	\$9,562,975	36.3%
Faculty Temp Budget	\$102,500	\$(91,238)	\$83,250	\$(1,893)	\$(3,333)	N/A
ICR	\$404,423	\$377,838	\$342,184	\$275,982	\$291,753	-27.9%
PMP Revenue	\$117,465	\$92,075	\$54,993	\$73,038	TBD	TBD
Total	\$7,889,031	\$7,687,070	\$7,888,186	\$10,247,794	TBD	TBD
Faculty FTE	44.00	42.00	43.10	46.60	46.85	6.5%
Staff FTE	10.00	12.00	9.34	9.84	9.84	-1.6%

Currently, the Department of Civil, Environmental, and Architectural Engineering has an annual operating budget of ~\$12.5M. In addition to the ~\$10M in funds received from the College of Engineering and Applied Sciences each year, the department has several gift endowments that provide another ~\$2.5M in continuing support each year for departmental programs and initiatives for students, staff, and faculty. The endowments alone produce an income stream of ~\$100K that is used for purposes specified in the original donations, such as acquisition of instructional equipment, funding of student scholarships, and funding of named lecture series.

The staff, teaching assistant, and operating budgets are determined based primarily on student credit hour (SCH) generation, the number of undergraduate and graduate students in the Department's programs, and the number of faculty in the Department. Funds for additional teaching support are added when the SCH generation per faculty member exceeds the College average. The CEAE department chair and staff, with inputs from the Executive Committee, creates budget based upon teaching, research, and administrative needs. The budget is presented to the Executive Committee for approval each fall with updates throughout the year as necessary.

1. Describe the process used to establish the program's budget and provide evidence of continuity of institutional support for the program. Include the sources of financial support including both permanent (recurring) and temporary (one-time) funds.

The campus went through a phased budget model design, change, and implementation from 2020 – 2022. The old model allocated funding to colleges, schools, and campus support units using an incremental model. Budgets for colleges, schools and campus support units were based on what they had received the previous year, plus or minus a small amount depending

on whether campus revenues increased or decreased. Only a small percentage of revenues might be available in a typical year for investment in mission-aligned projects or activities. Interviews with deans, vice-chancellors and business officers conducted in 2019 suggested that innovative teaching and research ideas and initiatives could be stifled by our previous budget model. Our previous model lacked transparency and the flexibility to respond to external factors. The prior funding model was still based on inputs such as enrollment, degrees, credit hours, grant expenditures and awards, current faculty lines, etc., but there was a recognized need to look holistically at the allocation rather than just small incremental changes year over year. The goals for the new model are to:

- Provide greater flexibility for strategic investments and to respond to the rapidly changing higher education landscape, including opportunities and crises that may arise.
- Increase transparency, enabling the campus community to better understand and engage in budgetary discussions that further the university's mission and strategic objectives.
- Better reflect our values and priorities, instead of reflecting legacy decisions that may no longer be relevant.
- Provide enhanced incentives to support and reward growth in key areas, respond to declines, and ensure accountability for the use and allocation of funding.
- Focus on the whole allocation, and not just the incremental changes that might occur year-over-year.

The new model includes elements that enable the university to better support retention, graduation, and diversity, equity and inclusion goals. The new model is an incentive-based model, whereas the current model is an incremental model.

Under the new model, the budget for department or program is determined via a two-step process. Step one is the incentive budget model recently adopted which credits tuition revenues based upon the college of record of the student population and upon the college of instruction for the courses that said student population enrolls in. Once the home college of the department is credited with its share of the undergraduate and graduate tuition revenue, those funds are then put through a college level budget model. The funding that comes to the department via this two-step process includes continuing and temporary budget to pay for faculty, staff, graduate students, student hourly employees, fringe benefits, operations, and financial aid. Additional funding comes to the department via indirect cost recovery on the sponsored research activity of the department. As this is the first year of the new budget model, all department and program budgets are being “held harmless” relative to last fiscal year with additional funding provided for new faculty hires, merit increases, and increased indirect cost recovery from overhead on sponsored research. “Hold harmless” means that all colleges and campus support units will receive **at least as much** funding in fiscal year 2022-2023 as they did in the previous year while the new model is implemented. This approach creates **budget stability** while also allowing us to see how the model works and to adjust as needed. The College continues to grow in all facets of its operation and department and program budgets will receive additional funds for their portion of the growth.

More information about the campus budget model can be found here:

<https://www.colorado.edu/bfp/budget-model>

2. Describe how teaching is supported by the institution in terms of graders, teaching assistants, teaching workshops, etc.

Teaching support from the institution is provided via the campus budget model which then flows through the college budget model to the respective departments. The units then, based upon their design and needs, determine the number of graders, TAs, and other support needed to best meet the needs of their student population at the undergraduate and graduate levels. The University of Colorado also places a priority on supporting faculty. Through the Leadership Education for Advancement and Promotion (LEAP) Program, faculty have an opportunity to participate (within their first four years on campus) in an Introductory Leadership Workshop with other junior faculty. This is a two-and-a-half-day, skill-based workshop held on campus two to three times each year. Additionally, the Center for Teaching and Learning offers all faculty a variety of professional development workshops throughout the year in establishing strong learning environments and discipline-specific pedagogy.

3. To the extent not described above, describe how resources are provided to acquire, maintain, and upgrade the infrastructures, facilities, and equipment used in the program.

The success of our faculty and students is predicated on the quality and age of our infrastructure, facilities, labs, and equipment. The University and the College put a priority on ensuring these are the very best that can be provided at the time. Over the last decade over \$200M have been invested in Engineering to either renovate existing spaces or to build new buildings that will accommodate not only the student growth of our College but also the depth and breadth of the research portfolio. The funding for this has come from campus and the College via funding from deferred maintenance, capital asset planning, debt issuance, startup funding, and calls for smaller renovation and beautification projects throughout the College.

4. Assess the adequacy of the resources described in this section with respect to the students in the program being able to attain the student outcomes.

The campus and the college continue to strategically place resources towards increasing the retention and graduation of its students and achieving our student outcomes. Financial support for students comes in the form of institutional financial aid, financial aid provided by the college, student hourly and work-study positions, and funding for assistantship positions. Ancillary support comes in the form of extensive undergraduate and graduate advising, health and wellness programs and counseling, support for student groups, a multitude of opportunities for undergraduate and graduate level research, and connections with industry for capstone projects as well as internships and post-graduation job opportunities. Through updating of student spaces, labs, classrooms, and the construction of new buildings, the infrastructure support has been extensive.

C. Staffing

All staff members complete specific training courses upon hiring. These include a general campus employee orientation, college orientation, harassment and discrimination awareness,

fiscal code of ethics, and IT security. Training specific to individual positions is facilitated by the campus and college. For example, initial training of the undergraduate advisors is supported by the dean's office. The Program's office manager also holds regular staff meetings to review best practices and any procedural changes. As needed, the office manager and financial manager also recommend additional training courses for their supervisees, such as interpersonal conflict resolution or communication courses. Self-directed training is also available for the professional development of staff, which is often facilitated by the office manager and finance manager.

The college additionally supports training and professional development for staff with funding for exam fees, training sessions, workshops, conferences, certification programs or other activities that enhance professional skills. The request may be directly related to the individual's current job or may enhance general professional development and should be in alignment with CU Boulder's strategic emphasis on leadership, innovation and positive impact. Funding of up to \$500 per staff member per fiscal year and per event is available on a first-come, first-served basis. A 1:1 or greater cost share is expected from the staff member's unit.

The CEAE department has an excellent staff to support the Civil Engineering program:

- Human Resources and Operations Manager (Madison Lane)
- Office Operations Coordinator (Andraa von Boeselager)
- Student Services & Curriculum Coordinator (Rebecca Rico)
- Undergraduate Academic Advisor Area Director (Erin Jerick)
- Undergraduate Academic Advisors (Rebecca Dizon, Toni Gossett)
- Financial Services Manager (Kathy Stutzman)
- Senior Finance & Grant Specialist (Sharon Mackey)
- Senior Finance & Grant Specialist (Tracy Hertzfeld)
- Senior Communications Specialist (Susan Glairon)

Part-time student assistants are hired on an as-needed basis to assist with special activities demanding more staff time.

The Department has a contract with the University's Office of Information Technology (OIT) to provide desktop support to faculty and staff, and to its Bechtel Lab Computer Lab. This OIT contract is equivalent to approximately a half-time position. The Department supports the Laboratory positions through its operating budget. The OIT contract is supported through program fees.

The Department participates in the College's Staff Excellence Program. This program funds - (i) opportunities for staff training and professional development, (ii) performance-recognition awards, (iii) a peer-mentoring program, and (iv) engagement in social events and college activities. The Department financially supplements the College's program to assist in professional development for the staff. Professional development and training strengthens staff members' capabilities to take on additional responsibilities, (e.g. the latest upgrade of the Human Resources and Financial Systems, CU Marketplace, CU-SIS student information system, and the new graduate application system). Staff are also given the opportunity to

enroll in job-related or career enhancing classes on campus, taking advantage of the tuition benefit of 9 credit hours per academic year. Staff arrange work time, if necessary, with their supervisor, to take these classes.

Staff Awards

The Staff Excellence Program was formed in 2009 based on recommendations made as part of strategic planning. These recommendations include staff growth, training, engagement, and recognition, as well as improving efficiency of administrative processes. Listed below are several opportunities for staff to help meet these recommendations.

- The Commitment to Excellence Award was established by the college to retain excellent staff by creating a supportive work environment for its employees. Recipients of this award shall have reached a five-year anniversary of continuous service as a professional exempt or classified staff member of the college with an appointment of at least 50% time.
- Staff Incentive Award recognizes classified and exempt professional staff employees' special accomplishments or contributions to the college, such as innovate ideas, creativity and exemplary performance while undertaking special projects or tasks. The form of the award is a cash award that would generally not exceed \$100 in value, though occasionally awards up to \$500 in value may be made for particularly substantial service. Funding is provided by the nominating unit. Nominations may be submitted at any time via a short email to the Dean and the CEAS Director of Human Resources.
- The Employee Recognition Award recognizes outstanding classified and professional exempt staff. The award is rotated between the various departments and programs of the College on a monthly basis so that each unit (or clusters of small units) has an opportunity to honor a staff member once each academic year. The award amount is \$500 (funding provided by the nominating unit).
- [College of Engineering Outstanding Staff Award](#) recognizes a staff member who has made outstanding contributions that benefit the students, staff and faculty of a CEAS department, program, or the college itself. As many as three staff may be selected for this honor each year. The award is presented annually and the winner receives a stipend of \$2,000.
- College of Engineering and Applied Science Staff Advisor Award recognizes staff advisors who demonstrate exceptional advising skills and who may serve as role models to other staff advisors in the College. This award is given annually and carries a \$1,000 stipend. Recipients of the award are selected based on the scores and comments received on class and advising surveys conducted by the College.

In addition to the awards mentioned above, several departments and programs have established unit-specific staff awards to honor their employees.

D. Faculty Hiring and Retention

The dean, with advice and discussion with the department chairs, assigns growth and replacement (losses due to retirements, resignations, etc.) faculty lines to departments. Faculty recruiting is the responsibility of the department executive committee. Once the department in consultation with the Dean has determined it is allowed to recruit for the following academic year, the executive committee recommends the search area or search

areas to the voting faculty for approval. An ad hoc search committee is then formed from all members of the executive committee supplemented by other faculty who agreed to be on the committee after being invited by the executive committee.

The ad hoc committee is responsible for advertising the position(s), evaluating candidates and recommending to the Chair and the faculty a slate of candidates to be interviewed. The slate must be approved by the Dean. The search committee will organize the campus visit by the finalists and provide the faculty with an evaluation and ranking of the candidates after all visits are complete. The voting faculty shall discuss the candidates and vote by secret written or electronic ballot on which candidate to recommend to the Dean.

In some cases, the search will be for an interdisciplinary faculty member. In those cases, the search committee will have members from several departments. Detailed information about the procedures for faculty hiring are found at <http://www.colorado.edu/engineering-facultystaff/recruitment-process-tenure-track-faculty>.

When the department has selected its preferred faculty hire, the Dean must then approve the individual. Note that if a faculty is being hired with tenure, the individual must be reviewed through the entire standard tenure process (review by primary unit, first level review, Dean, VCAC, and eventually approved by the Regents).

To retain current qualified faculty, the University benchmarks its salary and benefits against peer institutions. The College and University can also offer a retention package if a faculty member has a competing offer from another university. Retention packages vary, but typically include salary increases, student support, reduced teaching load, lab space or other benefits to entice the faculty member to stay.

E. Support of Faculty Professional Development

The College and the Department provide funds for professional training at workshops or national meetings. These opportunities are available to all faculty on a “funds available” basis. Examples include a College program that sends faculty to American Society for Engineering Education (ASEE) meetings and workshops, and a program to provide travel funds for faculty to visit funding agencies, with the Department providing funds to match what the College is providing.

The College supports professional development of faculty through the Faculty Excellence Program colorado.edu/engineering-facultystaff/awards-incentives/college-awards/faculty-excellence-program, which provides a number of financial support opportunities. This includes:

- **Dean’s Faculty Fellowships** - Selected faculty members are given one semester off from teaching a course, to focus on a major initiative in research and scholarly work or development of substantial educational materials or initiatives
- **Dean’s Seed Funds for Novel Ideas** - Discretionary funds up to \$10,000 (\$15,000 if multiple units involved) provide seed support for new ideas, and are matched 1:1 by the department or program
- **Dean’s Performance Awards** - \$5,000 awards are given for top performance in categories such as research, teaching, professional progress, and overall performance of junior faculty based on annual performance evaluations for the prior calendar year

- **Matching funds** for research grants, laboratory renovation funds, and travel to funding agencies
- **Sabbatical Supplement Program** - This program offers an additional 20% of the academic-year salary to faculty members taking full-year sabbaticals, on top of the normal 50% of the academic-year salary that they receive on sabbatical. The department then retains the remaining 30% of the academic-year salary, and the faculty member is responsible for raising (or forgoing) 30% of her or his salary. In addition, the Dean will provide \$4,000 in discretionary funds for research, travel, etc. to each faculty member who successfully applies for this program.

PROGRAM CRITERIA

The program criteria for civil engineering programs include requirements for both curriculum and faculty. Each of these requirements and how the CU Civil Engineering program fulfills the requirement are explained below.

1.1 The curriculum must prepare graduates to: apply knowledge of mathematics through differential equations, calculus-based physics, chemistry, and at least one additional area of basic science.

All Civil Engineering students in the BS program take 34 credits of math and basic sciences, including three semesters (12 credits) of calculus, one semester of differential equations and linear algebra (4 credits), two semesters of calculus-based physics with a laboratory (9 credits), one semester of basic chemistry with a laboratory (5 credits), and engineering geology (3 credits). [These courses are shown on the block diagram in **Criterion 5: Curriculum** and associated Table 5-1.]

The description for Engineering Geology is below:

CVEN 3698 (3) Engineering Geology: Highlights the role of geology in engineering minerals; rocks; surficial deposits; rocks and soils as engineering materials; distribution of rocks at and below the surface; hydrologic influences; geologic exploration of engineering sites; mapping; and geology of underground excavations, slopes, reservoirs, and dam sites. Includes field trips. Requisites: Requires a prerequisite or corequisite course of CVEN 2121 or GEEN 2851 or ASEN 2001 or MCEN 2023 and APPM 2350 or MATH 2400 (all minimum grade C-). *Many CVEN students take this course; as such, the syllabus is included in Appendix A and a course dossier has been prepared as part of the display materials.*

Performance in subsequent engineering courses both depends on and reinforces students' basic knowledge in mathematics, physics, and chemistry. Calculus and differential equations (APPM 1350, 1360, 2350, 2360) and Physics 1 (PHYS 1110) are prerequisites for all fundamental engineering courses in Civil Engineering. Basic chemistry (CHEM 1114 and CHEN 1201) is a prerequisite for the required course Fundamentals of Environmental Engineering (CVEN 3414). These courses are in turn prerequisites for the various proficiency and CEAE elective courses.

Measures of students' attainment of proficiency in math and basic science depends on internal measures such as student work in civil engineering courses requiring application of these fundamentals, and on external measures such as the Fundamentals of Engineering (FE) Examination. As described in **Criterion 4: Continuous Improvement** for student outcome 1, ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics, our direct and indirect evidence indicates adequate student fulfillment of this outcome.

1.2 The curriculum must prepare graduates to: apply probability and statistics to address uncertainty.

All Civil Engineering students are required to take a three-credit course in probability, statistics, and decisions (CVEN 3227, junior year). The course description is: “Introduces uncertainty based analysis concepts and applications in the planning and design of civil engineering systems emphasizing probabilistic, statistics, and design concepts and methods.” A syllabus for the course is included in Appendix A.

1.3 analyze and solve problems in at least four technical areas appropriate to civil engineering

The current curriculum requires all civil engineering students to take a fundamental level course in five technical areas of civil engineering (construction, environmental, geotechnical, structures, and water resources). These courses are recommended to be taken in fall of the junior year. Each course includes analyzing and solving problems. The FE exam results seem to indicate sufficient levels of knowledge across these five topic areas. As well, students routinely rate problem solving high in these five fundamental courses, as shown below.

Technical Area	Required Fundamental Course	Student FCQ rating for problem solving (0-5)
Construction	CVEN 3246 Introduction to Construction	3.6-3.86
Environmental	CVEN 3414 Fundamentals of Environmental Eng	4.14-4.7
Geotechnical	CVEN 3708 Geotechnical Engineering 1	4.75-4.83
Structures	CVEN 3525 Structural Analysis	2.68-3
Water resources	CVEN 3323 Hydraulic Engineering	4.43-4.88

1.4 conduct experiments in at least two technical areas of civil engineering and analyze and interpret the resulting data;

There are three courses that all civil engineering students are required to take that include embedded laboratories:

- CVEN 3161 Mechanics of Materials (related to the structural area of civil engineering)
- CVEN 3323 Hydraulic Engineering (related to the water resources area of civil engineering)
- CVEN 3708 Geotechnical Engineering 1 (related to the geotechnical area of civil engineering)

				Student FCQ rating	
Course	Role	Hours of Lab / semester	# of laboratory projects	Design and conduct experiments	Analyze and interpret data
CVEN 3161 Mechanics of Materials 1	Required	30	3 or 4	3.75-4.63	4-4.69
CVEN 3323 Hydraulics	Required	18	4	4.33-4.79	4.57-4.75
CVEN 3708 Geotechnical Engineering 1	Required	12	6	4.39-5	4-4.69

1.5 design a system, component, or process in at least two civil engineering contexts;

The proficiency courses in civil engineering include design, with the exception of the water resources course Hydrology - because the fundamental Hydraulics course required for all students is design-intensive. Students select three proficiency courses in three different proficiency areas, in addition to the fundamental courses listed in 1.3 that are required in all five areas. This ensures that all students experience design in a minimum of three civil engineering contexts. Faculty and student ratings of the extent of design in these courses is shown below.

	Courses (R = required, P = proficiency)	Student FCQ: "Design"	Faculty Rating of Design		
Context			Large	Medium	Small
Construction	CVEN 3256 Construction Equip & Methods (P) CVEN 3246 Introduction to Construction (R)	4.6-5.5	1	1	
Environmental	CVEN 3424 Water & WW Treatment (P) CVEN 3414 Fundamentals of Environmental Eng (R)	5.5-5.6	1		1
Geotechnical	CVEN 3718 Geotechnical Engineering 2 (P) CVEN 3708 Geotechnical Engineering 1 (R)	4.0-4.6			1 1
Structures	CVEN 4545 Steel Design (P)Or 4555 Reinforced	5.4 4.5-5.0	1		

	Concrete Design (P)				
Water Resources	CVEN 4333 Hydrology (P) CVEN 3323 Hydraulics (R)	3.2-3.7 5.0-5.6	1		1

1.6 include principles of sustainability in design

The first time that civil engineering students include the principles of sustainability in design is in the CVEN 1317 Introduction to Civil Engineering course in their first semester. The students are grouped into teams and must design a truss bridge using the Bridge Designer online program. For the class the bridges are judged on factors that map to the three pillars of sustainability: cost (economic), environmental impacts, social factors (aesthetics, etc.), and deflection (relates to safety). This follows a homework assignment on sustainability where they have been introduced to the ENVISION sustainable infrastructure rating system.

Later in their senior capstone design course, students are encouraged to apply the ENVISION rating system in their design; ENVISION is reintroduced in the Professional Issues course the preceding semester. In the senior capstone course, CVEN 4899, students evaluate and design sustainability features in their projects. Students provide design solutions for their client after considering life-cycle costs, material availability, renewable sources, energy consumption and the long and short-term impact on the environment and public health. These solutions are conveyed to their client in their base design and through value alternatives.

1.7 explain basic concepts in project management, business, public policy, and leadership

These elements are all included within the Professional Issues course. There are lectures and three homework assignments that relate to these topics: Business and Public Administration; Public Policy; and Leadership vs. Management. Project management is covered in the CVEN 3246 introduction to Construction course that is required for all students (fall junior year).

1.8 analyze issues in professional ethics

The required CVEN 1317 Introduction to Civil Engineering course in the first year introduces students to the ASCE Code of Ethics and presents case studies for examination. In addition, CVEN students must take CVEN 4897 Professional Issues, in which the topic of ethics is covered in detail. The syllabus for CVEN 1317 Introduction to Civil Engineering and CVEN 4897 Professional Issues is included in **Appendix A**.

1.9 explain the importance of professional licensure

In the CVEN 1317 Introduction to Civil Engineering course, students are introduced to the process to become a licensed PE and why it is important; ethics homework assignments asks students to share their ideas on this issue. In addition, major course objective for CVEN 4897 Professional Issues, is for students to explain the importance of professional licensure and the path to become a licensed PE. Students also prepare to take the Fundamentals of Engineering (FE) exam. Taking the FE exam is a graduation requirement of all CVEN students. The syllabus for CVEN 1317 Introduction to Civil Engineering and CVEN 4897 Professional Issues is included in **Appendix A**.

2.1 Faculty Qualifications to Teach Design

“The program must demonstrate that faculty teaching courses that are primarily design in content are qualified to teach the subject matter by virtue of professional licensure, or by education and design experience.” (ABET, EAC, 2017-2018, p. 12)

For the capstone design course in civil engineering, a team of four faculty routinely teach the course. In recent years, the course is coordinated and led by senior instructor Matt Morris, who is a licensed Professional Engineer in the State of Colorado and a LEED Accredited Professional. Other instructors vary somewhat each term. Each term the course includes a minimum of one instructor who is a licensed PE. Instructors are summarized below:

CVEN 4899 Instructors

Term	Instructor Team
Spring 2020	Balaji (water), Regueiro (geotech), Morris (construction, PE), Liel (structures PE)
Spring 2021	Morris (construction, PE), Balaji (water), Liel (structures, PE), Regueiro (geotech)
Spring 2022	Morris (construction, PE), Balaji (water), Hubler (structures), Regueiro (geotech)
Spring 2023	Morris (construction, PE), Balaji (water), Dehwah (structures), Regueiro (geotech)

For the instructors who are not PEs (as noted in the table above), design experience is summarized below with more detail provided in the individual resumes in Appendix B.

Name	Summary of Design Experience for Design Course Instructors Not PEs
Balaji	Associate Research Scientist LDEO, Columbia University; interned with Alembic Chemicals, Hindustan Cables Ltd and Engineers India Ltd.
Dehwah	PhD Thesis on” Modeling of electrokinetic nanoparticle injection and coupling effects in hygro-thermo-chemical transport in concrete”

	<p>-Master Thesis on “Energy-based solution for the buckling of CFRP stiffened stainless steel cylindrical shells”</p> <p>-Lab Instructor: teach and prepare lab experiments for Advanced Mechanics of Materials course.</p> <p>-BOLD student success center (SSC) Lead Tutor during summer-2022.</p> <p>-Engineering Intern: Design a multi-story car parking and commercial mall, Construction Projects Department</p> <p>-Structural design and analysis of a multi-story hotel (13 floors). Design the hotel using alternative slab systems in order to select the most economic system. Integrate the design with the Geotechnical discipline by using a 3D (soil-foundation) interaction. In addition, integrate the project with the Transportation field by designing a 3 basement floors garages.</p>
Hubler	<p>Prof. Hubler’s research addresses structural evaluation and redesign, including development’s in the design code. This expertise is enacted through professional service including: Voting Member for ACI 209 Creep and Shrinkage of Concrete, 2012 – 2013, secretary for subcommittee on rate type modeling;</p> <p>RILEM Technical Committee MDC – Multi-decade creep and shrinkage of concrete: material model and structural analysis, 2012-2013.</p>
Regueiro	Please see design experience below.

The instructors for other required or proficiency courses in the curriculum with large design elements are shown below.

Req	Required CVEN 3323 Hydraulic s	Proficiency CVEN 3256 Constr Equip & Methods	Required: CVEN 3414 Fund. of Environmen tal Engr,	Required: CVEN 3708 Geotech I	Proficiency: CVEN 4545 Steel Design	Proficiency: CVEN 4555 Reinforced Concrete Design
Instructor	Neupauer (PE)	Senseney (PE)	Masters	Pak Regueiro Dashti	Hearn (PE)	Hearn (PE)

A brief summary of the design experience for each of these individuals without a PE license and not previously described for senior design above is provided below.

Shideh Dashti, Ph.D., 2004-2006 worked with ARUP (New York City) and Bechtel (San Francisco) Geotechnical groups, where worked on several engineering projects in the US and around the world involving the design of foundation systems, slopes, and underground structures and tunnels.

Sheldon Masters, Ph.D. Worked environmental engineering consulting for 6 years before joining CU Boulder. During that time I was involved in many projects that involved water treatment plant design and operation. I also conduct research related to drinking water treatment and distribution system water quality

Ron Pak, Ph.D., Assoc. Engineer CF Braun & Co. 1981-1982; Assistant Structural Designer in 1979 for Chau, Lee, & She Architects & Engineers; consulting

Richard A. Regueiro, Ph.D. Prior to joining the faculty at CU, Prof. Regueiro served as a lecturer at Stanford University and a member of the technical staff of the science-based materials modeling department at Sandia National Laboratories for 7 years. He develops models for simulating inelastic deformation and failure in saturated and partially saturated soils and rock and bound particulate materials (e.g. sandstone, asphalt, concrete).

2.2 The program must demonstrate that it is not critically dependent on one individual.

There are multiple individuals among the CEAE faculty who are able to teach all of the courses in the curriculum. Many of the courses rotate among faculty on a routine basis, while other courses have typical instructors and others fill in during sabbatical and other leaves. The table below summarizes the various instructors for the required courses for the B.S. degree in CVEN over the past seven years. With our large faculty size, our program is not critically dependent on any individual.

Course (Department, Number, Title)	Instructors 2019-present
CVEN 1317 Introduction to Civil and Environmental Engineering	Bielefeldt
CVEN 2012 Introduction to Geomatics	Senseney, Pfeffer
CVEN 1027 Engineering Drawing	Andryauskas, Cayko, Gore
CVEN 2121 Analytical Mechanics 1	Pfeffer, Shakeri, Zhou, Xi, Song, Echeverria
AREN 2110 Thermodynamics	Henze, Likins White, Hernandez, Zuo
CVEN 3313 Theoretical Fluid Mechanics	Gooseff, Brucker, Holland, Connor, Blaskey
CVEN 3161 Mechanics of Materials 1	Xi, Srubar, Hubler, Jungclaus
CVEN 3698 Engineering Geology	Amadei, Pfeffer, Unger
CVEN 3246 Introduction to Construction	Senseney, Morris
CVEN 3323 Hydraulic Engineering	Gooseff, Neupauer

CVEN 3525 Structural Analysis	Song, Corotis, Ghosh, Hearn, Saouma, Mahdavi
CVEN 3414 Fundamentals of Environmental Engineering	Miller, Chambers, Kim, Straub, Masters
CVEN 3708 Geotechnical Engineering 1	Zhang, Regueiro, Pak, Dashti
CVEN 3227 Probability and Statistics	Corotis, Liel, Torres-Machi
CVEN 3111 Analytical Mechanics 2	Amadei, Song, Pourhamadian
CVEN 4899 Senior Design Project	See previous
Proficiency: CVEN 3424 Water and Waste Water Treatment	Linden, Summers, Corwin, Ma, Seyedi, Ley
Proficiency: CVEN 3256 Construction Equipment & Methods	Senseney, Bastias, Goodrum, Bhandari
Proficiency: CVEN 3718 Geotechnical Engineering 2	Pourhamadian, Pak, Regueiro, Dashti, Madabhushi, Zhang
Proficiency: CVEN 4333 Hydrology	Kasprzyk, Livneh, Kravits, Bjarke
Proficiency: CVEN 4545 Steel Design or CVEN 4555 Reinforced Concrete Design	Hearn, Liel

ACCREDITATION POLICIES AND PROCEDURES MANUAL

A. Accreditation Status

The Civil Engineering Bachelor of Science degree is accredited by the Engineering Accreditation Commission of ABET, <https://www.abet.org>, under the General Criteria and the Civil Engineering Program Criteria.

B. Publicization

Accreditation Status

<https://www.colorado.edu/ceae/accreditation>

Program Educational Objectives (PEOs) & Student Outcomes (SOs)

<https://www.colorado.edu/ceae/about/undergraduate-degrees/civil-engineering-educational-objectives>

Enrollment and Graduation/Degree Data

<https://www.colorado.edu/engineering/accreditation>

C. Safety Manual: CIEST Laboratory

Center for Infrastructure,
Energy, and Space Testing
(CIEST)

Operations and Safety Protocol

Prepared by

Thomas Bowen & Victor Saouma

Revisions by

Victor Saouma, Petros Sideris & Yunping Xi

October 2014

&

Brad Wham

October 2017

Department of Civil, Environmental, and Architectural Engineering
University of Colorado Boulder

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For your safety and for the safety of those around you, please adhere to the safety guidelines of CIEST.

Below is a summary of the most important safety requirements for use of the labs. Please be sure to review them prior to using the laboratories, and always check with CIEST staff if you have any questions.

1 GETTING STARTED

The Center for Infrastructure, Energy, and Space Testing (CIEST) is currently managed by the CIEST Manager, Dr. Brad Wham, and Co-directors Prof. Mija Hubler and Prof. Shideh Dashti.

CIEST places the safety of individuals in the lab above all else. As such, all individuals wishing to access the lab must comply with the following policies:

- Review this Safety Manual and prepare for a safety test with a designated CIEST personnel
- Fill out and submit the *Release from Responsibility, Assumption of Risk and Waiver*, available at the end of this document
- Fill out and submit the *User Agreement and Acknowledgement of Safety Orientation*, available at the end of this document
- If you are starting a new project, fill out and submit a CIEST Research Information Sheet to the CIEST staff

Hours of Operation for the CIEST facilities are Monday to Friday from 8:30am to 5:00pm. All doors to CIEST are locked at the end of the day. After hours and weekend operations must be approved by the CIEST Management.

All tasks taking place in the CIEST lab or making use of CIEST equipment, tools and machinery must be approved by the CIEST staff.

Due to the risk posed by the testing and machining environments within CIEST, CIEST is **not** a walk-through lab. Access to CIEST must be approved by lab personnel.

Any questions should be directed to Brad Wham (Brad.Wham@colorado.edu), Mija Hubler (Mija.Hubler@colorado.edu) and Shideh Dashti (Shideh.Dashti@colorado.edu).

2 IN CASE OF INJURY

2.1 EMPLOYEE ON-THE-JOB (OTJ) INJURY PROTOCOL

If you are injured while OTJ please follow the following procedure. Please note that CU Risk Management pays for all OTJ injuries (including ambulance rides) and requires injured employees to follow certain protocols to receive care. For medical emergencies, or if you are unsure of what to do, [CALL 911](#). First responders can provide additional first aid and tell you if you need the ambulance or not, and you are never charged for an ambulance showing up or for taking one to the hospital if you are injured OTJ.

1. Before administering care, assess the scene and person for safety hazards. Identify the cause of the injury. Do not approach the person unless the scene is safe.
2. If the person is awake and responsive and there is no life-threatening or severe bleeding, put on appropriate PPE (such as disposable gloves for any bleeding) and get the First Aid Kit. Inspect the person for all injuries and administer first aid as required. If the person requires treatment beyond first aid for their injury, they are required to seek treatment at one of CU's Designated Medical Providers, a list of which is available at the CU's Risk Management Website.
3. If there is severe bleeding, head injury, any injury severe enough to be questionable, or if the person cannot transport themselves to get care, [CALL 911](#).
4. If the person appears to be unresponsive, shout to get their attention, tap their shoulder, and look for normal breathing. Check for responsiveness for no more than 5 seconds. If the person is unresponsive, [CALL 911](#). If the person is not breathing, ensure that they are face-up. Begin CPR or use an AED if one is available. If the person is breathing and does not appear to have obvious signs of injury, roll them onto their side and obtain information about what happened while you wait for first responders to arrive.
5. After treatment, you have 4 days to complete the Employee Injury Report Form on Risk Management's Website. Failure to do so may reduce your Worker's Compensation. Report your injury to Brad Wham, Shideh Dashti, Mija Hubler, and Brice Lucero as soon as you are able.

2.2 NON-EMPLOYEE INJURY PROTOCOL

For medical emergencies, or if you are unsure of what to do, [CALL 911](#). First responders can provide additional first aid and tell the student or non-employee whether they need the ambulance or not. No one can be charged for the ambulance unless they choose to ride it to the hospital or if the first responders determine that the injured person needs emergency medical attention. Note that students and all non-employee users of the lab are required to sign a liability waiver provided to CIEST by the University.

The injury procedure for non-employees is outlined in steps 1-4 above.

3 PERSONAL PROTECTION EQUIPMENT (PPE)

Personal Protection Equipment (PPE) is required to both enter Ciest and use its equipment, and the level of PPE must be adequate for the activity being performed. The lab provides the following PPE for use by all individuals in the lab:

- Hard Hats
- Gloves
- Safety Glasses
- Up to APF 10/N95 Respiratory Protection

Individuals in the lab are responsible for utilizing the correct PPE to protect themselves and others from injury. If you are unsure of what PPE you need to complete a task, you are responsible for asking Ciest personnel. Please note that it is the responsibility of the Principal Investigator to provide PPE, other than what is provided by Ciest, for their researchers or employees working in the lab. This may include, and is not limited to, long pants, steel-toed boots, high-grade respiratory protection, hearing protection, and/or hazardous materials storage and disposal devices.

3.1 HAZARDOUS MATERIALS

All persons working in any fashion at Ciest MUST receive Hazardous Materials safety training from the Environmental Health & Safety Program on Campus. This is mandated by University policy. All such personnel will be given 60 days to receive the training and failure to do so will result in a revocation of lab access until policy compliance is satisfied.

Prior to procurement or production of any Hazardous Materials researchers MUST review all storage and disposal guidelines outlined on the University's Environmental, Health and Safety website (<https://ehs.colorado.edu/>). Regarding the Hazardous Materials Used or Produced section on the "Research Information Sheet" included at the end of this document, please list all materials to be used as they may be considered harmful by themselves (the status of which may change in different states) or with combinations with other materials used within the laboratory.

Hazardous materials should be handled only within their designated areas and must be stored and disposed of properly. It is the responsibility of the lab user to know how to safely store and dispose of all materials they use in the lab. A project in the lab is not considered complete until all materials have been stored or disposed of properly. Failure to properly store and dispose of materials, hazardous or not, will result in a disposal fee from the lab and a warning. Continued failure to comply with the storage and disposal policy will result in revocation of lab access. If you are not sure of designated areas and/or

appropriate disposal methods and storage locations, please contact the Ciest staff. We are here to assist you with your research.

3.2 MATERIALS, MACHINERY, EQUIPMENT AND TOOLS

Before you use any materials, machinery, tools and equipment, you need to receive permission and training by Ciest staff. Lab users may only use tools, machinery, and materials that they have received explicit permission and training to use by Ciest staff and may only use them for their intended purpose. When finished, please return all materials, machinery, equipment, and tools to their designated location in safe and clean condition. **If damage occurs to any machinery, equipment, or tools during operation, please report to Ciest personnel immediately.**

Most of Ciest's electrical equipment and tools are contained in a limited access storage area. You may sign-out these items Monday-Friday from 9:00am - 4:30pm with a Ciest personnel. Please remember to return them by the end of each day, so that we can make them available for other lab users.

Ciest personnel are available to assist you. Please ask for their help rather than risking personal injury or damage to any equipment. **Operation of the forklift and overhead crane is restricted to trained Ciest personnel only.** The Ciest Manager or a designated employee may make exceptions on a case specific basis.

3.3 BASIC RULES

1. Wear a hard hat and safety glasses at all times you are on the strong floor. Use all PPE as directed.
2. Long-hair must be tied back to keep it from catching in equipment or machinery.
3. Keep doors closed at all times, and locked after 5:00pm, Monday - Friday and all weekends.
4. Observe safety rules for hoisting
5. Keep areas clean and uncluttered. Work areas must be cleaned after use.
6. Clean and return tools after use
7. DO NOT modify machinery, equipment, or tools for your own use
8. Immediately notify Ciest staff of damaged machinery, equipment, or tools
9. All materials, hazardous or not, must be stored and disposed of properly. No pouring chemicals of any kind down the drains.

4 SAFETY INTRODUCTION AND ORIENTATION TO CIENT AND LIABILITY WAIVER

At the back of this safety packet you will find two pages that must be filled out and returned to CIENT staff prior to beginning any work in CIENT. Those documents are the: (i) User Agreement and Acknowledgement of Safety Orientation, and (ii) Waiver of Liability Form.

4.1 AWARENESS

CIENT is covered with machinery and equipment that can cause life-threatening injury if interacted with improperly. All CIENT users are responsible for being aware of their surroundings, which both protects themselves and the other users of the lab. Being aware of your surroundings entails, but is not limited to, ensuring machinery is being used safely; ensuring materials are not positioned in an unsafe manner; watching for any hoisting activity; ensuring long hair is tied back; etc. CIENT staff reserve the right to revoke access to the lab if they have reason to believe someone's lack of awareness is compromising lab safety.

4.2 POWER TOOLS

4.2.1 General

When working with any of the power tools kept in the lab, proper PPE must be worn. This may include, but is not limited to:

- Steel-toed boots
- Safety goggles
- Gloves
- No loose clothing or hair
- Long pants

Plan how you intend to use all tools, equipment, and machinery and prep your work area before use. Be familiar with the power tool you are planning to use. If you are not familiar with the equipment, ask for assistance from CIENT staff.

4.2.2 Equipment

Always seek tool specific training from CIENT personnel before use. Always inspect the equipment for damage before use. Clean and return the tools when you are done with them.

4.2.3 Power Saws

1. Only use the saw as it is intended.
2. Ensure hands, hair, body parts, and loose clothing are secured and out of the way before use.

3. When applicable, use clamps or guards (i.e. clamp on steel chop saw)
4. If you change a blade, first unplug the saw. Ensure it is the right blade (size, arbor size and style, rpm rating) and that it is in the correct orientation, as well as tightly secured.
5. Be sure to ask for assistance if the object you are cutting is too large or cumbersome for one person to handle.

4.2.4 Power Drills

1. Ensure hands, hair, body parts, and loose clothing are secured and out of the way before use.
2. Ensure you are using the proper drill bit for what you are doing (end mills are not drill bits).
3. If using the mill or drill press, do not to drill into the support platform. Set up a depth stop or place a piece of scrap wood under the object you are drilling through.
4. All objects must be properly secured when being drilled through. This means utilizing clamps, vices, or other supports to immobilize the object.
5. Use the proper cutting lubricants when drilling. Failure to do so can cause unnecessary wear to the drill bits and damage the item being drilled through.
6. Use a safety chain to support the magnetic-based drill if used in any orientation other than vertical

4.2.5 Nail Gun/Stapler

1. Be sure the pressure on the compressor is set to the correct setting for the specific tool. Do Not use excessive pressure.
2. Only use with wood.
3. Ensure the safety of the environment around you. Do not point the nail gun where a nail could hit another person in the lab or damage other equipment.

4.2.6 Remington Powder Nail Gun

1. Wear additional PPE including ear protection and a hard hat. It is loud and the force of the nail can cause the concrete to shatter.
2. Notify people that you are using this tool and ensure that the environment around you is safe. Do not point the nail gun where a nail could hit another person in the lab or damage other equipment.
3. Only use charges and nails that are approved.

4.2.7 Grinders

1. Clean and inspect area around you before starting. Make sure there are no flammable materials nearby.
2. When grinding, pay attention to where the sparks are flying. Do not grind in such a fashion as to throw sparks onto other personnel in the lab or sensitive equipment.
3. Do not grind aluminum on bench grinders.
4. Use appropriate grinding wheels (size, arbor, material, rpm) and make sure they are in the correct orientation.
5. When using cut-off wheels on the handheld grinders, be sure to position yourself out of danger. The wheels may bind with the material and shoot the grinder back.
6. Make sure the grinding wheels are in good shape. Worn out grinding wheels will fragment during use and send pieces of the grinding wheel flying across the room.

7. Make sure the specimen being cut is correctly supported so it doesn't fall on you or others when the cut is complete.

4.2.8 Arc Welding, MIG Welding, and Plasma Cutting

For electric welders, there is a substantial risk of shock or electrocution if performed incorrectly. Failure to demonstrate adequate safety knowledge of the welding machine and process will result in an immediate revocation of access to the machine.

1. A Hot-Work Permit should be completed before electric arc welding is performed.
2. Inspect all equipment before welding. Look for frayed cables, poor connections, and proper grounding and shielding. Ensure the electrode holder and welding cable are well insulated and in good condition. Ensure all output terminals are insulated, which includes wearing rubber-soled footwear. Are the cables the right size for your job? Are they spread out properly to prevent overheating? Is the gas cylinder connected properly? Is the cylinder secured safely in an upright position? Is your workstation stable, secure, and easy to reach from where you're standing? Is there adequate ventilation in your workspace?
3. Welding currents create substantial Electro-Magnetic Fields (EMF) which can interfere with nearby equipment and medical implants such as pacemakers. Anyone with a pacemaker wishing to weld must contact their physician prior to performing any welding. All personnel welding should implement the following EMF procedures to minimize exposure to EMF from the welding circuits:
 - a. Route the electrode and work cables together and secure them with tape whenever possible.
 - b. Never coil the electrode lead around your body.
 - c. Never place your body between the electrode and work cables. If the electrode cable is on your right side, the work cable should be on your right side as well.
 - d. Connect the work cable as close to the area being welded as possible.
 - e. Do not work directly next to the welding power source.
4. Keep all flammable materials out of the workspace. This includes grease or oil of any kind.
5. Wear all proper PPE for welding. This includes the appropriate welding jacket, gloves, helmet, and respirator. Long pants and closed shoes must be worn. Other protective wear for heavy work or especially hazardous situations includes flame-resistant suits, aprons, leggings, leather sleeves/shoulder capes, and caps worn under your helmet. Hearing protection must also be worn to both protect the users hearing and to ensure flying sparks or metal stay out of your ears. **Arc welds release significant amounts of UV radiation. Failure to cover all exposed skin will result in UV burns.**
6. Ensure that proper ventilation is in place before beginning the weld, which includes ensuring that you are wearing proper respiratory protection. There are multiple severe risks that arise when welding without proper ventilation and respiratory protection, including exposure to toxic fumes or mass displacement of local oxygen supplies which can cause dizziness, unconsciousness, and death. **The fume plume from welding contains solid particles from the consumables, base metal, and base metal coating. This plume can contain, but is not limited to, Barium, Cadmium, Chromium, Lead, Cobalt, Copper, Manganese, Nickel, Silica, and Zinc. Exposure to these fumes without proper respiratory protection or ventilation can be fatal or cause lifelong respiratory problems and/or cancer.** Be aware of what you are welding: was the metal treated with a degreasing agent which will react and outgas when exposed to heat? Is the metal coated in a hazardous substance? If you

do not know what it is, DO NOT WELD IT. There is one easy way to reduce the risk of fume exposure: keep your head out of the fume plume at all times! If you ever feel lightheaded, dizzy, or a burning sensation in your eyes, nose, or throat, cease welding and get fresh air immediately. Failure to comply with proper ventilation and respiratory protection guidelines can result in the death of you and other people working in the lab.

7. Ensure the work area is dry. Failure to do so exponentially increases the likelihood and severity of electrocution. This includes making sure that your own perspiration is not comprising the safety of the work area.
8. Ensure the settings on the machine are correct for the job you are about to perform.
9. Use the appropriate equipment to handle materials after placing a weld. The materials will be extremely hot and will cause serious burns if you attempt to pick it up without proper equipment and PPE.
10. Protect all other lab users by properly shielding the light from the weld or plasma arc. Looking at an arc without eye protection can cause permanent eye damage, even if only briefly or from a large distance.
11. Never strike an arc on compressed gas cylinders.
12. Place used electrode stubs in a metal container.
13. Always wear a helmet when overhead welding and when other overhead hazards exist.
14. Do not attempt to modify any of the welding machine equipment. Note that power inside the welding machine does not go away when the machine is "turned off." Notify CUEST staff with any concerns you have about the state of the machine.
15. There must be a fire extinguisher in an easily and rapidly accessible location from the welding area.

4.2.9 Oxyacetylene Welding

Gas welding machines should be treated with the same level of precaution as live explosives.

Oxyacetylene welding setups have tanks of pure oxygen and pure acetylene. The oxygen and acetylene are not to be used, under any circumstances, for anything except for welding as the setup was designed for. Pure oxygen is not the same thing as air. Never use pure oxygen to blow out any piping or lines or for any such activity. Failure to do handle pure oxygen safely can result in an explosion. Pure acetylene is an unstable gas and has an auto-ignition temperature of 763-824 degrees Fahrenheit. This means that if acetylene is heated sufficiently or reaches 30 psi in a free state, it will violently decompose and explode. The acetylene should never be pressurized above 15 psig. Oxygen and Acetylene combusted together creates one of the hottest known flames with a burn temperature up to **6300 degrees Fahrenheit**.

6. A Hot Work Permit should be completed before oxyacetylene welding is performed.
7. Use only certified welding components.
8. Inspect all equipment before welding. Check gas cylinders, flashback arrestors, backflow/ pressure protectors, regulators, hoses, torches and shielding.
9. Check for leaks in the hoses, regulators and connections whenever you change tanks or suspect a leak.

10. Check equipment with soapy water, never a flame. If you detect or suspect a leak in the equipment, stop and effect repairs promptly.
11. Do not use oil on the torch, blow pipe, valves, regulators or any other portion of the equipment as oxygen and oil can start a fire.
12. Do not use pliers on apparatus. Use the proper wrench. Keep wrench on acetylene cylinder valve while in use so it can be shut off quickly if necessary.
13. In the event of a fire emergency, tanks should be shut off and removed from the area. If this is not possible, responding emergency personnel must be notified of the hazard before entry.
14. Do not exceed 15 psi for acetylene or an explosion may occur.
15. Make sure connections are tight when you change tips or other apparatus. Do not over tighten.
16. Do not use oxygen or any other compressed gas to blow dirt off your clothes.
17. Do not permit equipment to run over the hoses; protect them from sharp objects, kinks, and heat sources.
18. Use flint spark lighter; never matches or cigarette lighters
19. Follow the proper sequence for torch ignition.
20. Use special care when cutting, so hot pieces do not fall onto you or equipment hoses
21. Lighted torches should never be laid down, hung up or left unattended.
22. Never "crack" a cylinder in the vicinity of an open flame or fire source.
23. Keep cylinders upright and secured. Keep valve caps on cylinder when not in use.

4.2.10 Slug Cutter

1. Make sure you have had hands on training.
2. Be sure you have enough cutting fluid.
3. Cut at a steady pace as the material will heat-harden and burn up our bit if you start and stop or jam bit into material with varying force.
4. Follow correct usage procedure from training or manual.

4.2.11 Ladders

At CU, there are approximately 20 ladder accidents each year. Consider the following: a Consumer Product Safety Commission report on ladder safety revealed that ladders are one of the most dangerous items in the work environment:

- Nearly 100,000 people are sent to the Emergency Department each year for ladder-related injuries.
- Elevated falls account for 700 occupational deaths every year, which amounts to **15% of annual occupational deaths.**
- Approximately 50% of all ladder-related injuries were due to individuals carrying items as they climbed

There are four main causes of ladder accidents:

1. **Selecting an Improper Ladder for the Job:** When selecting a ladder, ensure that you will not be exceeding the weight capacity or loading height limit for the ladder (you should never step onto the top two rungs of a ladder, and the ladder should extend at least 3 feet above where it is being supported at the top).

2. **Using Worn or Damaged Ladders:** Ladders, like all materials, fatigue with repeated loading over time. Ladders should be periodically inspected for signs of fatigue, such as cracking. If any signs of fatigue are found, the ladder should be discarded immediately.
3. **Improper Use of the Ladder:** Using a ladder improperly by using too few points of contact (you should always have 3 points of contact with the ladder), reaching for things from the top of the ladder, not facing the ladder when climbing, etc. can cause the ladder to tip over or otherwise fail to safely support you. When climbing a single or non-self-supporting (i.e. step ladder) ladder, always have someone to support the base of the ladder.
4. **Incorrect Placement of the Ladder:** Ladders should never be placed against a fragile or mobile surface such as windows or doors and should never be placed next to high-traffic areas or moving objects that are not locked, blocked, or guarded.

The following is a list of safety guidelines that must be followed for use of ladders in the lab:

1. Periodic safety inspections of all ladders is a requirement. Before using a ladder, you should inspect it thoroughly. Check for cracks in the steps and rails, loose or damaged hinges, steps, or braces, and that the ladder is clean and dry. On extension ladders, check that the safety feet are in place and that ropes are not frayed or worn. Metal ladders should be checked for dents and/or bends.
2. **Check if anything is on top of the ladder before moving it.** People are known to leave tools such as wrenches or scissors on top of ladders which can fall and cause life threatening injury.
3. Read and follow all marking and labels on the ladder. Never paint a ladder as this may hide markings and labels as well as cracks and defects.
4. Avoid electrical hazards when using a ladder. Observe overhead for powerlines or exposed electrical equipment. Only non-conductive (non-metal) ladders may be used near electrical equipment.
5. Always maintain 3-point (two hands and a foot, two feet and a hand) contact on the ladder when climbing. Keep your body centered over the middle of the step/rung and always face the ladder when climbing.
6. Ladders must be free of any slippery material on the rungs, steps, or feet.
7. Do not use a self-supporting ladder (e.g. a folding step ladder) and a single ladder (e.g. a non-folding extension ladder) or in a partially closed position.
8. Never use the top rung of a ladder as a step unless it has been designed for that purpose.
9. Only use ladders on a stable and level surface, unless it has been properly secured (top and bottom) to prevent displacement.
10. Do not place ladders on boxes, barrels, or other unstable bases to obtain additional height.
11. Never shift or attempt to move a ladder while a person or equipment is on it.
12. An extension ladder or straight ladder used to access an elevated surface must extend at least 3 feet above the point of support. Never stand on the top 3 rungs of a straight, single, or extension ladder.
13. The proper angle for setting up a ladder is to place its base a quarter of the working length of the ladder from the wall or object serving as the point of support for the top of the ladder. For example, if a 20 ft. ladder makes contact with the top of a wall at 16 ft. of its length, the base of the ladder should be 4 ft. away from the wall.
14. A ladder placed in a location where it can be displaced by other work activities must be secured to prevent displacement or a barricade must be erected to keep traffic away from the ladder.
15. Be sure that all locks of an extension or self-supporting ladder have engaged before climbing.
16. Never exceed the maximum load rating of a ladder. Be sure to incorporate the weight of any equipment you are carrying.

4.2.12 Scaffolding

Scaffolds are used when above-ground jobs require more workers and/or equipment than a ladder can safely handle. Scaffolds should be designed, maintained, and used in compliance with safety standards and specifications. Use only manufacturer's parts when replacing damaged or worn components. A scaffold should be made of strong metal, stress grade lumber, or approved fiberglass. When in use, the scaffold should be secured to the building or wall (mobile scaffolds and ladder stands shall have wheel "locks" to prevent movement). When working on or around a scaffold, a hard hat and safety shoes with nonskid soles should be worn. A safety harness and/or tie offs may be required. The first line of protection in scaffold safety is to inspect a scaffold carefully before each use to look for:

- Footings that are sound, rigid, and capable of holding the intended weight (boxes, barrels, etc., do not qualify)
- Guard rails that are 2" X 4" wide and 3 to 3 1/2 feet high
- Guard rail supports every 10 feet on all open sides
- Toeboards that are 4" high on all sides
- Screens between the guard rails and toeboards if people will pass underneath
- Ladders or other safe methods to get on and off the scaffold
- Poles, legs, or other uprights that are plumb and secured
- Planks that extend 6 to 18 inches over the end supports on wooden scaffolds
- Cross braces on metal scaffolds
- Pedestrian traffic should be routed away from overhead work

Scaffolding can only be used if more than one person is present. Do not use scaffolding by yourself.

4.3 LIFTING SAFETY

Heavy lifting is one of the leading causes of injury in the workplace. In 2001, the Bureau of Labor Statistics published a report detailing that 36% of missed workdays were the result of injuries to the shoulders and back.

When lifting objects to head height or above, regardless of the method, a hard hat is required. Safety glasses should be worn at all times.

4.3.1 Awareness

Take stock of your environment prior to engaging in lifting activities. Do you have enough space to lift? Is your path clear from obstructions and/or slipping or tripping hazards?

1. Be aware of people and equipment around you so nobody gets hit with what you are lifting.

2. Make sure you use the correct pick points when lifting equipment.
3. Think about the next person who will be lifting what you are moving
4. Make sure they will be able to get under it to pick it up (put it on blocks!)

4.3.2 Crane Safety

Cranes are one of the leading causes of workplace fatality. In 2008, the CPWR reported an annual average of 42 deaths in the construction industry directly related to crane incidents. The most common crane accidents are crane-related electrocution (25% of fatalities), crane-load strikes (21% of fatalities), crane strikes (20% of fatalities), and crane collapse (21% of fatalities). Observe the following guidelines:

1. Make sure all straps are in good shape and are rated high enough for what you are lifting. Make sure that the object you are lifting is balanced. There are three ways to use lifting straps:
 - Choker: Least strength
 - Vertical: Medium strength
 - Basket: Strongest
2. Inspect clevises for wear/fatigue and ensure that the clevis you are using has the appropriate rating for the weight you are hoisting. Tighten clevis completely, then back it off ½ of a turn before lifting.
3. Always attach a tag line to the object you are hoisting to keep it balanced and in control while in the air.
4. Ensure sufficient clearance before lifting, which includes inspecting the path that the hoisted object will take to its destination.
5. Always attach a tag line to what you are lifting to keep it balanced and in control while in the air.
6. Make sure you have clearance along any walls you are lifting by, crane can rip stuff off the wall (i.e. pipes, wires, conduit). Make sure you have vertical clearance if moving something over another object (can't go over South Stack).
7. When moving to the loading dock, make sure the wedge is in place before moving crane out the door.

4.3.3 Forklift Safety

Forklift operators and employees around the forklift are susceptible to collisions, falls, tip-overs, and struck-by collisions.

1. Only trained and certified individuals over the age of 18 may operate the forklift.
2. Always operate the vehicle in accordance with the manufacturer's instructions.
3. Always wear a seatbelt when the forklift has one.
4. Never exceed the rated load of the forklift, which is 3500 lbs for the current forklift in the lab.
5. Never raise or lower the load while the forklift is in motion.
6. Always keep the forklift away from platform and ramp edges, or other surfaces which would cause the forklift to fall or tip over.
7. Inspect the pathway of the forklift and ensure you have enough clearance for raising or lowering the load.
8. Always use the horn at cross aisles, blind corners, or other obstructed areas.
9. Do not give rides or use the forklift to lift people.

10. Inspect the forklift regularly and remove it from service if it is found to be in unsafe operating condition.
11. Ensure that the forks are free of excess oil and grease.
12. Set the parking brake when done with the fork lift. Also set the parking brake when lifting someone in the bucket.
13. **The forklift** has a capacity of 3500 Lbs. This capacity is never to be exceeded.
14. When using straps to lift with the fork lift, you must use clamps to prevent straps from slipping off.
15. When done with the fork lift, put forks on the ground or hidden under something so no one trips over them.

4.3.4 Manual Lifting Safety

A person's ability to lift things manually in a safe manner varies from person to person. For some stronger people, they may be able to carry 50-100 lbs safely; for others, attempting to lift this weight poses a danger to their physical health and safety as well as the health and safety of others. In general, be aware of your personal safe weight lifting capacity. You should never have to strain to pick something up. As a rule of thumb, if you cannot carry something comfortably, get another person to help you move it. If the item is too heavy for two people to lift, perform the lift using the assistance of a machine, such as the crane, the forklift, or a pallet jack.

If you must pick something up, pick up the item from a squat or deadlift position and lift with a straight spine – do not lift and twist your back. If you are uncomfortable lifting or unfamiliar with proper lifting form, ask for assistance from Ciest staff. Someone else can help you lift the item or you can use a machine to do it.

4.4 HYDRAULIC SAFETY PROTOCOL

4.4.1 Hydraulic Components in Ciest

On a day to day basis, Ciest may use any of the three hydraulic pumps associated with the lab. This may include working with any of the three MTS machines, any of the actuators, and any other component of the hydraulic systems. Ciest may work on hydraulics during periods of routine maintenance as well. The forklift also utilizes hydraulics for lifting.

Hydraulic equipment uses confined liquid pressure to exert a mechanical force, generally through a piston-like actuator. As such, hydraulic operators are subject to hazards from high-pressure liquids and large mechanical forces, both of which have the potential to cause fatal injury. All safety devices should be in place and in good condition before the equipment is put into operation. All personal **must** be trained on

how to use the equipment before operating it. Safety glasses and a hard hat are required to use any hydraulic equipment.

4.4.2 Introduction to Hydraulics

1. Hydraulic systems must store fluid under high pressure using accumulation.
2. Safe hydraulic system performance requires regular general maintenance.
3. Proper coupling of high and low pressure hydraulic components and pressure relief valves are important safety measures.

4.4.3 Hazards of Hydraulics

1. Burns from the hot, high pressure spray of fluid
2. Bruises, cuts or abrasions from flailing hydraulic lines
3. Injection of hydraulic fluid into the skin
4. Fire and explosion from Conveyed Fluids, or Static-Electric Discharge
5. Electric shock- hydraulic hoses are conductive and may carry charge

4.4.4 Pinhole Leak Injuries

Pinhole leaks in hydraulic lines are difficult to locate. A person may notice a damp, oily, dirty place near a hydraulic line. Not seeing the leak, the person runs a hand or finger along the line to find it. When the pinhole is reached, the hydraulic fluid can be injected into the skin as if from a hypodermic syringe. Immediately after the injection, the person experiences only a slight stinging sensation and may not think much about it. Several hours later, however, the wound begins to throb and severe pain begins. By the time a doctor is seen, it is often too late, and the person may lose a finger or their entire arm.

To reduce the chances of this type of injury, **never** check for a hydraulic leak using your hand, even if your are wearing a glove. Alternatively, run a piece of wood or cardboard (or other such material) along the hose to detect the leak.

4.4.5 Improper Coupling

Another hazard is improper coupling of low- and high-pressure hydraulic components. Do not connect a high-pressure pump to a low-pressure system. Do not incorporate a low-pressure component, hose or fitting into a high-pressure system. Component, hose or fitting ruptures are likely to occur.

Make sure to use appropriate hoses for the system. Never use a hose rated lower than the intended pressure for the system. Be aware of the minimum bend radius of hoses, and use elbows and adapters when necessary. Design hoses for change in length due to machine motion and tolerances.

4.4.6 Fire and Explosion Risks

Fires and explosions can occur even with fire-resistant hydraulic fluids under certain conditions. Escaping fluids may form a mist or fine spray, which can explode upon contact with an ignition source. Fluids passing through the hose may generate static electricity, which can ignite fluids under static-electric discharge conditions.

4.4.7 Accumulators

Accumulators can become lethal projectiles if disassembled when pressurized. To ensure safety during disassembly, relieve the nitrogen pressure using the accumulator charging kit. Ensure that hydraulic pressure is at zero before routine maintenance operations. Make sure to use the right type of gas, because mixing gasses can produce unpredictable results. Avoid rapid and extreme pressure changes, which can damage valve seals. Transferring gasses from high to low pressures creates freezing temperatures, this occurs when venting pressurized gas.

4.4.8 Maintenance

An improperly maintained hydraulic system can lead to component failures. Safe hydraulic system performance requires general maintenance.

1. Weekly checks for oil leaks and worn hoses.
2. Keep contaminants from hydraulic oil and replace filters periodically.
3. Check accumulation monthly, more frequently in special cases.
4. Be aware during routine operations of any changes in the behavior of hydraulic systems

4.4.9 Tips for Safe Operation

1. Never service the hydraulic system while the machine engine is running unless absolutely necessary (bleeding the system).
2. Do not remove cylinders until the working units are resting on the ground or securely on safety stands or blocks; shut off the engine.
3. When transporting the machine, lock the cylinder stops to hold the working units solidly in place.
4. Before disconnecting oil lines, relieve all hydraulic pressure and discharge accumulators to avoid lethal projectiles
5. Be sure all line connections are tight and lines are not damaged; escaping oil under pressure is a fire hazard and can cause personal injury.
6. Always use hoses appropriate for the system with correct specifications
7. When washing parts, use a nonvolatile cleaning solvent.
8. To ensure control of the unit, keep the hydraulics in proper adjustment.

4.5 HOT WORK

4.5.1 Building Systems

1. Fire sprinklers kept operational
2. Building ventilation protected from smoke and fumes
3. Fire alarm system kept operational; detectors removed only if necessary in the vicinity if they would likely be activated by the work; Facilities Management Fire Alarm Group requires at least 72 hour notice to perform these functions.
4. Cutting and welding equipment in good operating condition

4.5.2 Personnel / Occupant Protection

1. Workers protected from smoke, fumes, toxic materials by use of exhaust ventilation or other approved safety measures
2. Vision screens / barriers in place
3. Confined space entry permit / procedures in place
4. Energized equipment locked / tagged out of service
5. Workers properly trained in use of equipment

4.5.3 Within 35 Feet of Work

1. Floors swept clean of combustibles
2. Combustible floors swept down & covered with damp sand, metal or other spark / heat shields
3. Combustible and flammable materials removed
4. Fixed combustibles and flammables covered with covers, guards, and/or shields
5. Wall and floor openings covered with non-combustible covers
6. Covers suspended beneath work to collect sparks

4.5.4 Work On Walls or Ceilings

1. Construction must be non-combustible and without combustible covering.
2. Combustibles moved away from opposite side of wall and second fire watch provided

4.5.5 Work on Enclosed Equipment (tanks, ducts, plenums, etc.)

1. Confined space entry permit / procedures
2. Compressed gases out of confined space
3. Equipment empty, cleaned of residues, pressure released, purged of vapors, gases shut off

4.5.6 Fire Watch (at work site)

1. Fire watcher shall be present during and for 30 minutes after operation. Fire watcher shall search for any smoldering or flaming ignition and extinguish any such sources.
2. Fire watcher shall be supplied with hose and fire extinguishers of proper size and type and be properly trained in use of same.
3. Fire watcher shall be trained in emergency procedures and activating fire alarm.

4. The permit applicant or their representative shall protect all combustibles from hot work ignition sources. This includes sealing of floor and wall penetrations.
5. Fire watcher shall stop hot work if any of the safety precautions cannot be met.

4.5.7 Intent of Fire Alarm System

The intent of National Fire Protection Association (NFPA) 72 for a protected premise connected to a central monitoring station, requires the fire alarm system to: notify occupants to evacuate when there is a fire in the building, notify the central monitoring station (Facilities Management Service Desk) to initiate emergency personnel response, and activate fire protection systems, e.g., release door holders and shut down fans.

4.5.8 When Building Fire Watch Is Required

1. When, in the opinion of the Authority Having Jurisdiction (FM FPG), it is essential for public safety, one or more qualified persons are to be on fire watch duty (Uniform Fire Code, sec.25.117).
2. In the event of temporary failure of the alarm system or an excessive number of accidental alarm activations, the Jurisdiction's authorized representative may require the building owner or occupant to provide stand-by personnel until the system is restored (UFC, sec.14.110).
3. When work necessitates disabling any fire detection, suppression or alarm system component which would conflict with the intent of NFPA 72.
4. Whenever welding or torch cutting is performed in locations where other than a minor fire might develop, or any of the conditions required by NFPA 51B exist, as indicated on the Hot Work Permit.

4.5.9 How Building Fire Watch is Accomplished

1. Fire watch personnel are to keep diligent watch for fires and are not to perform any other simultaneous duties.
2. Fire watchers are to be familiar with facilities and procedures for sounding an alarm in the event of a fire. The fire watch is to have planned a response method meeting the intent of NFPA 72 (see A. above).
3. Fire watchers are to have fire extinguishing equipment readily available and be trained in its use, including practice on test fires.
4. Fire watchers are to look for signs of fires in all exposed areas, and try to extinguish fires if it can be done safely and within the capacity of the equipment available, and after sounding the building fire alarm to summon emergency response personnel.
5. Fire watch is to be maintained for at least one half hour after completion of hot work operations.

5 SAFETY WAIVER FORMS

See pages that follow



Notice to Participants of Risk and Waiver of Responsibility

Activity _____

NOTE: IT IS IMPORTANT THAT THIS DESCRIPTION BE CLEAR AND UNIQUE.

Date: Starting _____ Ending _____

Participant Name _____

Parent/Guardian Name (if minor participant) _____

Emergency Contact Phone Numbers _____

The University of Colorado welcomes you as a participant in this activity, including the use of University of Colorado facilities and equipment. Please read through the following important information.

I exercise my own free and voluntary choice to participate in the designated activity, including use of facilities and equipment provided by the University of Colorado. **I understand and assume all associated risks of the designated activity. These risks include, but are not limited to** (add risks specific to event here):

I agree to assume all risk of personal injury or loss, bodily injury (including death), damage to or loss of, or destruction of any personal property resulting from or arising out of participation in the designated activity. I also release, waive, indemnify, hold harmless, and discharge the University of Colorado from all claims, damages, and injuries arising out of my activities, including my use of equipment and facilities provided by the University of Colorado.

The University of Colorado does not provide health insurance for individuals participating in activities made available or sponsored by the University of Colorado. As such, you or your personal health insurance will be responsible for payment of medical services and care for any injuries sustained during the designated activity.

I hereby certify that I have read and understand the provisions above. For participants under 18 years of age, the parent or guardian accepts the above terms and grants permissions for the student's participation on behalf of said minor, as **permitted by C.R.S. § 13-22-107.**

Activity Participant

Date

Parent/Guardian for Minor

Date

University of Colorado
Center for Infrastructure, Energy, and Space Testing (CIEST)

User Agreement and Acknowledgement of Safety Orientation

I, _____, hereby agree to abide by the rules and policies of the Center for Infrastructure, Energy, and Space Testing at the University of Colorado while using this facility. I have received and reviewed a copy of these rules and policies as part of the laboratory safety orientation given to me by laboratory personnel.

Signature

Date

Print Name and Affiliation

Always remember:

1. This is **NOT a walk-through lab**. You must be working/have a valid reason to be here!
2. Please notify CIEST personnel of your presence. Anonymous use of the lab is not allowed.
3. **Ask CIEST personnel to borrow tools or use equipment.** DO NOT rummage through the office for tools, or use anything in the lab without permission!
4. Follow the **dress code** (steel-toe boots, hard hat and safety glasses).
5. **Clean up** after yourself.

University of Colorado
Center for Infrastructure, Energy, and Space Testing (CIEST)

Research Information Sheet

Nature of Experiment, Equipment Used:		Location in Lab (Room #):	
Start Date:		Expected End Date:	
Research Assistant (RA) Name, Phone, Email		Principle Investigator (PI):	
Hazardous Materials Used or Produced:			
Date of Most Recent CU-Sponsored Hazardous Materials Safety Training:			

Safety Manual

Lighting Laboratory

Engineering Center ECST 313
University of Colorado Boulder

Laboratory Managers

Sandra Vásquez, sandra.vasquez@colorado.edu

Jennifer Scheib, jennifer.scheib@colorado.edu

Contact Information

Emergencies: 9-1-1

For general inquiries, contact the laboratory managers.

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Introduction

The Lighting Laboratory is primarily a teaching and learning laboratory used to support Architectural Engineering coursework taken by students focusing on the subdiscipline of lighting. In this context, the space is used for design projects, laboratory experiments, and other active learning exercises both during and outside of class time. The space is also used to host events for the student chapter of the Illuminating Engineering Society, to house experimental setups for graduate student research, and to support hands-on learning related to our professional education programs.

The space consists of four rooms (Figure 1): an entry corridor (CR310), the main “lighting lab” room (ECST313), a storage room (ECST 311), and a supplementary “daylighting and controls lab” room (ECST320).

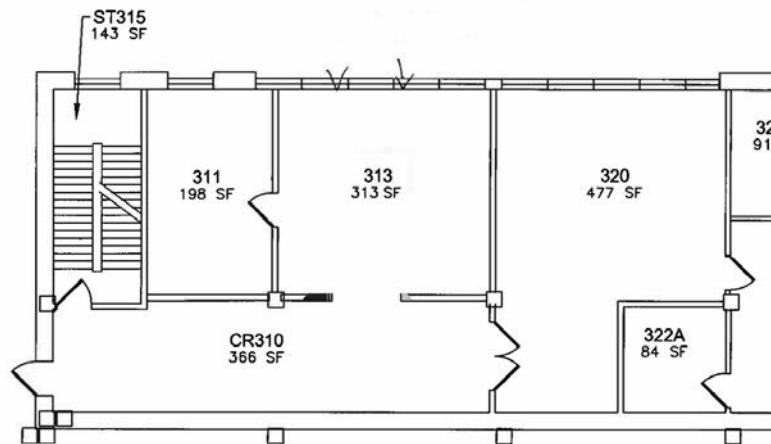


Figure 1: Lighting lab floor plan

Entry Corridor

The entry corridor is wide enough to house lighting demonstrations including adjustable panels for explorations of washing, grazing, and accenting various surfaces and materials, and wall-mounted boxes that allow for visualization of correlated color temperature and color rendering across different lamp types as seen in Figure 2.



Figure 2: Lighting demonstrations in main corridor (CR310)

Lighting Lab

The lighting lab has various luminaire types installed in an adjustable ceiling, blackout shades, and a system for hanging curtains across the lab to further divide, hang mockup objects, or darken the space. The space houses a wall-mounted goniophotometer that bends the path of light toward an illuminance meter using a large mirror that moves and locks in position using a counterweight and pin connector system.



Figure 3: Wall-mounted goniophotometer (left); blackout shades and curtain-hanging system (right)

Workshop and Storage Room

The storage room is directly adjacent to the lighting lab, and it houses lamps, luminaires, meters, tripods for mounting lamps, and myriad tools and materials used for demonstrations, model-making, and other course activities. This space also houses a working bench for student use. See Figure 4.

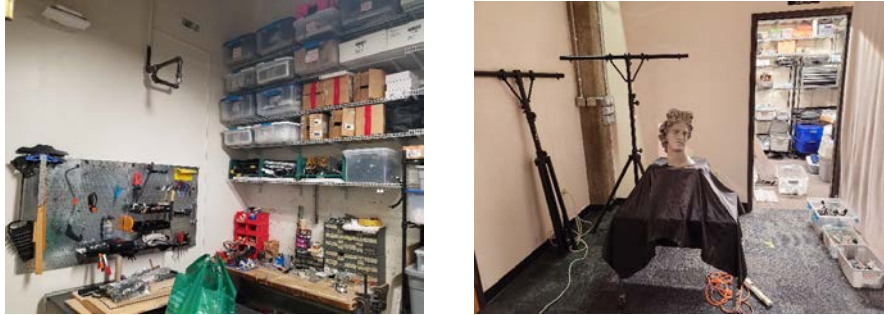


Figure 4: Workshop area in the storage room (left); view to the storage room from the lighting lab (right)

Daylighting and Controls Lab

The daylighting and controls lab has an automated, dual-shade system on the windows, and suspended direct-indirect luminaires connected to an architectural lighting control system. The lab also has four moveable wall panels that are set up to enclose a mock office space lighted by twelve RGBW LED luminaires (Figure 5). Cabinetry is mounted on two walls of the lab for storage of daylighting and controls equipment including microcontrollers, sensors, connectors, and power supplies.



Figure 5: Moveable walls to enclose a mock office space.

Additional Lighting Equipment

Three pieces of equipment are mounted on wheels and moved between spaces to accommodate teaching and learning activities. One is a cart with a mounted illuminance sensor meant to be aimed at the goniophotometer at different distances. The second is an integrating sphere for testing lumen output of sources. The last one is a frame to hold accent fixtures around a bust to test three-point lighting.



Figure 6: Cart with illuminance meter along with integrating sphere (left); frame with accent luminaires (right)

Laboratory Safety

The **primary entrance/exit** for the laboratory is located at the top of the stair tower, ST CHI-28. The door to the laboratory should be closed and always locked except when a laboratory manager or student TA/grader is present and running a class session or event. An additional entrance/exit is in the daylighting and controls lab. This door is to remain locked and alarmed but can be used as an exit in case of an emergency. The door leads to a different laboratory space, which has stairs to other floors of the Engineering Center. There is also an elevator, but it is not available for public use.

A **campus phone** is in the storage room, which is accessed through the main lighting lab room. The phone is located between the two large black cabinets on the interior wall.

A **first-aid kit** is also located in the storage room, which is accessed through the main lighting lab room.

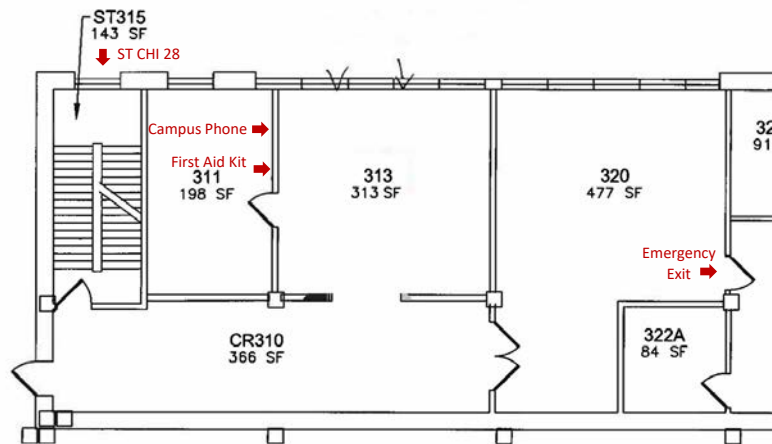


Figure 7: Location of entrance/exit doors, campus phone, first aid kit

Laboratory Procedures and Behavioral Expectations

The following are the procedures and behavioral expectations for all people using the lab:

- Obtain a key from a lab manager to access the lab. Do not share your key with anyone. Keys must be returned at the end of the semester or school year.
- Read and familiarize yourself with the Emergency and Incident Procedures section before using the laboratory.
- Do not work in the laboratory alone. Work in pairs, at a minimum, and let others know you will be using the space through a class sign-up sheet or email to lab managers.

- Do not block the corridor with objects such as backpacks, bikes, furniture, and the like. When working on demonstrations in the corridor ensure there is a clear path to the primary entrance/exit.
- Do not attempt to retrieve objects on shelves if the use of a ladder is required. The lab managers will have all materials needed for class activities and exercises ready.
- Do not bring the moveable ceiling up or down unless the lab manager is present. The ceiling must remain fully retracted and in the horizontal position unless used for an experiment or mockup.
- Do not leave hazardous materials such as spray paint and other compressed air containers in the lab.
- Do not paint or other materials that release fumes in the lab.
- Do not cut, solder, or use power tools anywhere other than in the workshop area.
- Do not take tools or equipment from the lab without consent from the lab manager.
- Be mindful of your noise level. The adjacent campus laboratory (through the alarmed door) is not acoustically isolated from the lighting laboratory.
- Leave the laboratory tidier than you found it to mitigate incidents such as cuts or tripping, and to support a culture of caution and care.
- Notify laboratory managers immediately with any questions about use or storage of equipment, or with concerns about the behavior of others using the space.

Emergency and Incident Procedures

If an emergency occurs in one of the lab spaces:

- If it is safe to do so, use the fire extinguisher mounted in the corridor near the entry door to put out fire.
- If it is safe to do so and the emergency includes equipment, deenergize the equipment by turning off switches or unplugging power supplies.
- **Use a cell phone or the phone in the storage room (accessed through the lighting lab) and dial 9-1-1.**
- Tell operators you are in:
 - The CU Boulder Engineering Center at 1111 Engineering Dr, Boulder, CO, 80309
 - Room ECST 313 at the top of stair tower, ST CHI-28

If a non-emergency incident occurs in one of the lab spaces:

- If it is safe to do so and the incident includes equipment, deenergize the equipment by turning off switches or unplugging power supplies.

- Use the first aid kit mounted on the interior wall of the storage room (accessed through the lighting lab) to treat minor cuts, burns, or bruises.
- Report the incident immediately to the laboratory managers.

Equipment Use Procedures

When participating in design activities using lamps, tripods, and moveable panels:

- Use the laboratory manager/instructor prepared setup.
- Use gloves to add, adjust, and remove lamps. These are in the workshop area in the storage room.

When participating in laboratory experiments:

- Use the laboratory manager/instructor prepared setup.
- Participate in training on use of goniophotometer prior to completing the class exercises.

When participating in controls demonstrations:

- Use the laboratory manager/instructor prepared setup.
- Do not touch line voltage equipment including lighting and blind control panels, ceiling-mounted luminaires, or demonstration setups and power supplies.
- Adjust sensors and power supplies for low voltage demonstrations (i.e., those using microcontrollers) only as described by the laboratory manager/instructor prior to class exercises.

Safety Manual
Larson Laboratory
Engineering Center ECCE210, 215, 220
University of Colorado Boulder

Laboratory Manager

Nicholas Clements, PhD., nicholas.clements@colorado.edu, 303-532-6546

Contact Information

Emergencies: 9-1-1

For general inquiries, contact the laboratory manager.

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Introduction

The Larson Laboratory is a research and teaching facility used to support the Architectural Engineering Department. Graduate and undergraduate students may leverage the laboratory in conducting research related to heating, ventilation, and air conditioning (HVAC) systems, hydronic systems, managing interior/exterior heat loads, indoor air quality, and energy efficiency. Research uses include the use of two test chambers equipped with independent air handling units (AHUs), or researchers may use the laboratory space to house stand-alone experimental setups. Laboratory equipment and chambers are also used for educational purposes, for example providing a space to train students on blower door testing and energy audit instrumentation use.

As shown in Figure 1, the first floor of the laboratory consists of an entry corridor, workspace, conference area, equipment storage areas (ECCE215), and two test chambers (east and west zones, ECCE220). The second floor of the laboratory consists of an office space (ECCE210) and a mechanical equipment area where the test chamber AHUs are located.

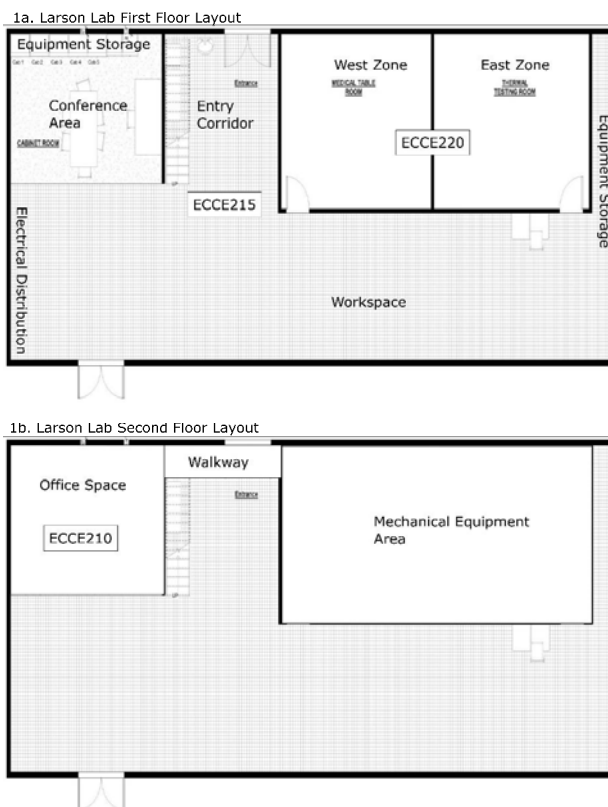


Figure 1. Larson Lab Floor Plan, (a) First Floor and (b) Second Floor.

Entry Corridor

The entry corridor consists of a kitchen and sink area and cabinets for historical equipment storage and document storage (Figure 2). The kitchen area includes a refrigerator, microwave, cabinets, coffee makers, electric kettle, and sink. Cleaning equipment is also stored in this area.



Figure 2. Picture of the kitchen and storage area of the entry corridor (ECCE215).

Workspace

The Larson Laboratory workspace, shown in Figure 3, is an area where stand-alone research setups are located. Limited capabilities exist for building experimental setups in this space, though tools and other equipment are available for simple building needs. This space has access to various water systems to allow testing with hydronic heating and cooling coils, for example. Any changes to plumbing systems are coordinated with the university's facilities management team. Currently this space is also housing multiple architectural engineering-related demonstration projects. Laboratory manager approval is required for use of the workspace for projects.



Figure 3. Picture of the workspace area (ECCE215).

Test Chambers

Two test chambers are located in the Larson Laboratory, designed to allow research and educational projects to leverage carefully controlled AHUs in projects. AHU-1 (up to 2000 CFM) serves the West Zone, currently setup to simulate an operating room. AHU-2 (up to 1000 CFM) serves the East Zone, currently setup for testing heat loads (Figure 4). The AHUs are controlled with a building automation system (BAS). Test chambers may be remodeled to fit the needs of specific projects, including changing ventilation design, heat loads, simulating various built environments, and installation of various instrumentation and other equipment. Use of the test chambers must be approved by the laboratory manager.



Figure 4. Pictures of the test chambers (ECCE220), West Zone (left) and east zone (right).

Mechanical Equipment Area

The mechanical equipment area, located on the second floor above the two test chambers, is where the AHUs and related systems are located (Figure 5). Access to this area must be approved by the laboratory manager. In this area, researchers can access supply, return, and exhaust ducting, ventilation fans, filters, heating/cooling coils, humidification systems, sensors, dampers, and other AHU-related components. As shown in Figure 6, outside air is brought into the AHUs from the east wall of the lab, and air is exhausted through a different penetration in the same wall. AHU-1 serves the West Zone and can supply up to 2000 CFM. AHU-2 serves the East Zone and can supply up to 1000 CFM. Dampers control the amount of return air that is mixed with outside air or exhausted to the outside. Each AHU is equipped with a cooling and heating coil, as well as a filter housing.



Figure 5. Pictures of the mechanical equipment area (left) and access door (right).

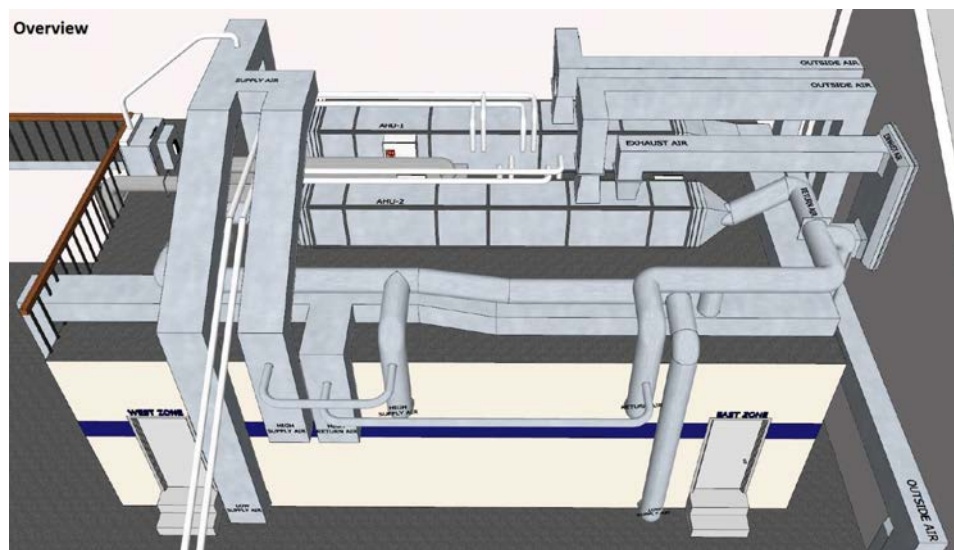


Figure 6. Drawing of the mechanical equipment area.

Equipment Storage

Two areas in the laboratory are designated as equipment storage areas, shown in Figure 7. Cabinets in the conference area house instrumentation including blower doors, thermal imagers, temperature/humidity data loggers, electricity monitors, air flow monitors, and air quality monitors. On the east wall of the laboratory, various equipment and building supplies are stored. An inventory is maintained by the laboratory manager noting the location and status of all instrumentation and equipment. Students must check equipment out from the laboratory manager for equipment use for classes. Graduate students can coordinate long-term equipment use with the laboratory manager.



Figure 7. Pictures of the equipment storage areas (ECCE215), in the conference area (left) and on the far edge of the lab (right).

Conference/Office Area

The conference area in Figure 8 includes two tables and a television used for meetings and holding office hours for courses. This area can serve as part of the workspace when tables are needed.



Figure 8. Picture of the conference area (ECCE215).

The office area in Figure 9 includes up to 9 workstations and conference table for students and serves as the office of the laboratory manager. The campus phone is in this room.



Figure 9. Picture of the office area (ECCE210).

Laboratory Safety

The **primary entrance/exit** for the Larson Laboratory is located along the north wall and connects to the Architectural Engineering department offices, as shown in Figure 10. This door remains closed but always unlocked, though the door to the Architectural Engineering department offices is locked at nights and on weekends. An additional entrance/exit is located along the south wall, which leads to the building roof and remains locked, requiring key card access. Similarly, on the second floor along the north wall there is a second roof access door requiring key card access. Two **fire extinguishers** are located on the first floor, and one is located on the second floor. A **first aid kit** is in the entry corridor, and a **campus phone** is in the office area.

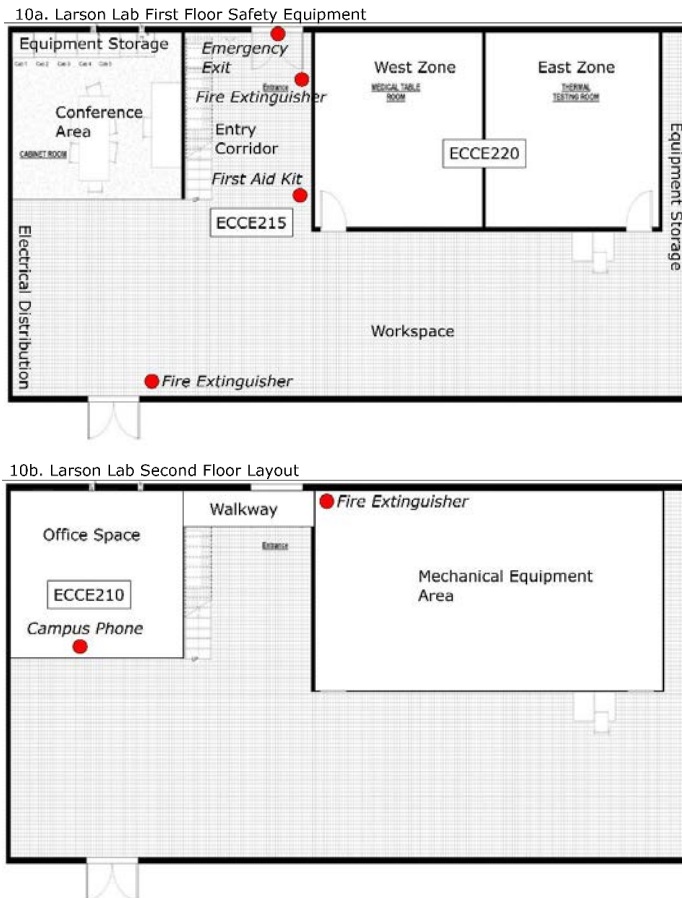


Figure 10. Location of entrance/exit doors, campus phone, fire extinguishers, and first aid kit.

Laboratory Procedures and Behavioral Expectations

The following are procedures and behavioral expectations for all people using the lab:

1. Obtain permission to use the workspace and test chambers from the laboratory manager.
2. Obtain a key to the Architectural Engineering department offices for off-hours laboratory access. Do not share this key with anyone, and keys must be returned when students leave the university.
3. Read and familiarize yourself with the Emergency and Incident Procedures section before using the laboratory.
4. Do not work in the laboratory alone. Work in pairs, at a minimum, and let others know you will be using the space by notifying the laboratory manager via email.
5. Wear close-toes shoes when doing any work related to using tools or other building equipment.
6. Coordinate with the laboratory manager and university facility managers when connecting to plumbing and electrical systems, as well as when using or modifying the AHUs.
7. Safely store all supplies and other equipment in designated areas and keep from introducing tripping/fall hazards.
8. Do not block the corridor, stairs to the second floor, or doors to the test chambers.
9. Do not attempt to retrieve objects on shelves if the use of a ladder is required. Contact the laboratory manager to access such equipment.
10. Do not modify the test chambers without coordinating with the laboratory manager.
11. Do not leave hazardous materials, such as spray paint or other compressed air containers, in the laboratory. A flammable materials cabinet is available for use in the workspace to house volatile and flammable materials.
12. Do not paint or use other materials that release hazardous fumes in the laboratory.
13. Keep the use of power tools in the laboratory to a minimum and always clean up your workspace after their use.
14. Do not take materials, tools, equipment, or instrumentation from the laboratory without approval from the laboratory manager.
15. Be mindful of your noise level, as the lab office area and department offices are adjacent.
16. Notify the laboratory manager immediately with questions related to laboratory use, equipment storage, behavioral concerns, and any other inquiries.

Emergency and Incident Procedures

If an emergency occurs in the Larson Laboratory:

1. If it is safe to do so, use the fire extinguisher mounted closest to the incident to put out a fire. Fire alarms are located throughout the laboratory in the case of a fire that cannot be put out with a fire extinguisher.
2. If it is safe to do so, in the event of an electrical issue unplug or trip power supplies to deenergize equipment.
3. Use a cell phone or campus phone and dial 9-1-1 in the event of a serious emergency or health incident. Tell operators you are in the CU Engineering Center 1111 Engineering Dr., Boulder, CO 80309, Room ECCE215 (or 210/220) in the Architectural Engineering Department.

If a non-emergency incident occurs in the laboratory:

1. Deenergize equipment, if safe to do so.
2. Use the first aid kit mounted in the entry corridor to treat minor cuts, burns, or bruises.
3. Report the incident immediately to laboratory managers and to your supervisor.

APPENDIX A – COURSE SYLLABI

APPM 1350 Course Syllabus

1. **Course Number and Name:** APPM 1350 Calculus 1 for Engineers
2. **Credits, contact hours, and categorization of credits in Table 5-1:** 4 credit hours; 3x50 minute lectures weekly and 1x50 minute recitation weekly; Basic Math and Science
3. **Course Coordinator:** Anne Dougherty (anne.dougherty@colorado.edu)
4. **Textbook:** Chapters 1-5 of Essential Calculus, Second Edition by James Stewart, March 2006
5. **Specific course Information:**
 - A. **Brief description of the content of the course (catalog description):** Topics in analytical geometry and calculus including limits, rates of change of functions, derivatives and integrals of algebraic and transcendental functions, applications of differentiations and integration. Students who have already earned college credit for calculus 1 are eligible to enroll in this course if they want to solidify their knowledge base in calculus 1.
 - B. **Prerequisites or co-requisites:** Requires prerequisite course of APPM 1235 or MATH 1021 or MATH 1150 or MATH 1160 or MATH 1300 (minimum grade C-) or an ALEKS math exam taken in 2016 or earlier, or placement into calculus based on your admissions data and/or CU Boulder coursework.
 - C. **Indicate whether a required, elective, or selected elective:** Required
6. **Specific goals for the course:**
 - A. **Specific outcomes of instruction:** (1) Understand the concepts, techniques and applications of differential and integral calculus, and (2) improve problem solving and critical thinking. This class will form the basis for many of the standard skills required in all of Engineering, the Sciences, and Mathematics.
 - B. **Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.**
7. **Brief list of topics covered:** Trigonometry, limits, derivatives, and integrals

APPM 1360 Course Syllabus

1. **Course Number and Name:** APPM 1360 Calculus 2 for Engineers
2. **Credits, contact hours, and categorization of credits in Table 5-1:** 4 credit hours, 3x50 minute lecture and 1x50 minute recitation weekly; Math and Basic Science
3. **Course Coordinator:** Anne Dougherty (anne.dougherty@colorado.edu)
4. **Textbook:** Chapters 6-9 of Essential Calculus, Second Edition by James Stewart, March 2006
5. **Specific course Information:**
 - A. **Brief description of the content of the course (catalog description):**
Continuation of APPM 1350. Focuses on applications of the definite integral, methods of integration, improper integrals, Taylor's theorem, and infinite series.
 - B. **Prerequisites or co-requisites:** Requires prerequisite course of APPM 1345 or APPM 1350 or MATH 1300 (minimum grade C-).
 - C. **Indicate whether a required, elective, or selected elective:** Required
6. **Specific goals for the course:**
 - A. **Specific outcomes of instruction:** This course extends the concepts and techniques of single-variable Calculus. The main objectives are to (1) improve integration techniques and applications of differential and integral calculus, (2) understand sequences and series, and (3) improve problem solving and critical thinking skills. This class will form the basis of your set of everyday working skills required for math, engineering, and the sciences.
 - B. **Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.**
7. **Brief list of topics covered:** Integration, sequences, series

APPM 2350 Course Syllabus

1. **Course Number and Name:** APPM 2350 Calculus 3 for Engineers
2. **Credits, contact hours, and categorization of credits in Table 5-1:** 4 credit hours; 3x50 minute lecture and 1x50 minute recitation weekly; Math and Basic Science
3. **Course Coordinator:** Anne Dougherty (anne.dougherty@colorado.edu)
4. **Textbook:** Essential Calculus, Second Edition by James Stewart, March 2006
5. **Specific course Information:**
 - A. **Brief description of the content of the course (catalog description):** Covers multivariable calculus, vector analysis, and theorems of Gauss, Green, and Stokes.
 - B. **Prerequisites or co-requisites:** Requires prerequisite course of APPM 1360 or MATH 2300 (minimum grade C-).
 - C. **Indicate whether a required, elective, or selected elective:** Required
6. **Specific goals for the course:**
 - A. **Specific outcomes of instruction:** This course extends the ideas of single-variable calculus (e.g. limits, differentiation, integration, optimization, fundamental theorems) to functions of several variables. Topics include vectors and vector operations, vector-valued functions and curves in space, multivariable functions, partial differentiation, multiple integrals, line integrals, surface integrals, and the theorems of Green, Stokes and Gauss. These concepts form the mathematical basis for many areas in science and engineering. The aim is for you to learn these concepts and to critically and creatively solve problems.
 - B. **Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.**
7. **Brief list of topics covered:** Vectors and vector operations, vector-valued functions and curves in space, multivariable functions, partial differentiation, multiple integrals, line integrals, surface integrals, and the theorems of Green, Stokes and Gauss.

APPM 2360 Course Syllabus

1. Course Number and Name: APPM 2360 Introduction to Differential Equations with Linear Algebra

2. Credits, contact hours, and categorization of credits in Table 5-1: 4 credit hours, 3 x 50 minute lectures weekly, 1 x 50 minute recitations weekly; Math and Basic Science

3. Course Coordinator: Anne Dougherty (anne.dougherty@colorado.edu)

4. Textbook: Differential Equations and Linear Algebra, Second Edition by Farlow, Hall, McDill, and West, February 2017

5. Specific course Information:

- A. Brief description of the content of the course (catalog description):** Introduces ordinary differential equations, systems of linear equations, matrices, determinants, vector spaces, linear transformations, and systems of linear differential equations.
- B. Prerequisites or co-requisites:** Requires prerequisite course of APPM 1360 or MATH 2300 (minimum grade C-).
- C. Indicate whether a required, elective, or selected elective:** Required

6. Specific goals for the course:

- A. Specific outcomes of instruction:** This course provides an introduction to ordinary differential equations and linear algebra. Topics include both qualitative and quantitative methods of solving differential equations, Laplace transforms, systems of first order equations, matrices, determinants, eigenvalues/eigenvectors and vector spaces.
- B. Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.**

7. Brief list of topics covered: Qualitative and quantitative methods of solving differential equations, Laplace transforms, systems of first order equations, matrices, determinants, eigenvalues/eigenvectors and vector spaces.

AREN 1027 Course Syllabus

1. **Course number and name:** AREN 1027 - Engineering Drawing
2. **Credits, contact hours, and categorization of credits in Table 5-1:**
3 Credits, 3 contact hours, Engineering Topics
3. **Instructor's or course coordinator's name:** Alex Gore
4. **Textbook:**
The "LIFT" - Revit Content Creation Package
The Creativity Code by Alex Gore
5. **Specific course information:**
 - a. **Brief description of the content of the course (catalog description):** Develops drawing and drafting skills for civil engineering projects in both hand drawing and software tools. Students will learn to read and interpret design and construction drawings.
 - b. **Prerequisites or co-requisites:**
Requisites: Restricted to Engineering Physics (EPEN), Architectural (AREN), Integrated Design Engineering (IDEN) or Civil (CVEN) Engineering majors only.
 - c. **Indicate whether a required, elective, or selected elective:** Required for AREN, Selected Elective for CVEN
6. **Specific goals for the course:**
 - a. **Specific outcomes of instruction:** The student will be able to understand and find information in drawings. Will be able to communicate their ideas via drawings, and with visual / oral presentations
 - b. **Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course:** Outcome 3, An ability to apply oral communications to communicate effectively with a range of audiences
7. **Brief list of topics covered:** Freehand Sketching, Hand Drafting Exercise, Reading Construction Documents, Simple Revit Families, Advanced Revit Families, Revit Cabin Redrafting Exercise, Design Case-Study, Final Design Project

AREN 2110 Course Syllabus

1. Course Number and Name: AREN 2110 Thermodynamics

2. Credits, Contact Hours, and Categorization of Credits in Table 5-1:

3 credits, 3 contact hours at 50 min each per week, engineering topics

3. Instructor's Name: Gregor P. Henze, Ph.D., P.E.

4. Textbook: Moran, M.J., Shapiro, H.N., Boettner, D.D., and Bailey, M.B. (2018).

Fundamentals of Engineering Thermodynamics, Enhanced eText, 9th Edition. John Wiley & Sons, Inc, ISBN-13:978-1-119-39138-8.

5. Specific course information:

- a. **Brief description of f description of the content of the course (catalog description):** The objectives of this course are 1) to introduce fundamental concepts of properties of materials, work, heat, internal energy, entropy, equilibrium, and relations derived from the first and second laws of thermodynamics, and 2) to learn how to apply these principles towards civil, environmental, and architectural engineering applications. Example applications include renewable energy production; power plants; fluid flow in ducts/pipes; thermal properties of building/construction materials and processes; geothermal systems; heating, ventilation, and air conditioning (HVAC) processes; energy balances in buildings; refrigeration; contaminant transport in air, water, and soil; climate change; the urban heat island effect; and energy use in transportation.
- b. **Prerequisites or co-requisites:** None
- c. **Indicate whether a required, elective, or selected elective:** Required

6. Specific Goals for the Course:

- a. **Specific outcomes of instruction:**
Upon completion of this course, students will be able to:
 - Explain the principles of mass and energy conservation and their use in AREN applications.
 - Evaluate thermodynamic systems and several forms of work, energy, and heat transfer.
 - Apply conservation of mass and energy for closed systems and control volume processes.
 - Explain the second law of thermodynamics, entropy changes, and device efficiencies.
- b. **Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course:** Outcome 1, An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

7. Brief List of Topics to be Covered: Introduction to thermodynamics terminology; processes, properties, and units; mechanical concepts of energy; additional forms of work and energy; heat transfer and energy balances; thermodynamics cycles; evaluating

thermodynamics properties; specific heats; real and ideal gases; conservation of mass for control volumes; conservation of energy for control volumes; analyzing control volumes at steady state; transient control volumes and system integration; introduction to idea gas mixtures and psychrometrics; psychrometric parameters; psychrometric chart; dehumidification and humidification in HVAC systems; the second law of thermodynamics; entropy; the second law of thermodynamics for closed systems and control; steady-state entropy balance, isentropic processes, and isentropic efficiencies; entropy balance

CSCI 1200 Course Syllabus

1. **Course number and name:** CSCI 1200: Introduction to Computational Thinking
2. **Credits, Contact hours, and categorization of credits in Table 5-13** credits (1-50 min lecture, 1-100 minute lab), 37.5 minimum contact hours
3. **Instructor or Course Coordinator Name:** James E. Dykes; Assistant Teaching Professor (instructor)
4. **Text Book and Other Supplemental Materials:** No Text; Uses Department Developed Materials
5. **Specific Course Information:**
 - a. **Brief description of the content of the course (catalog description):** Teaches computational thinking and techniques for writing computer programs using the Python programming language. Intended for students who realize that computational skills are beneficial to all fields of study, but who have little or no experience in programming or are not Computer Science majors. Students will be expected to create computer programs to solve problems in a range of disciplines.
 - b. **Prerequisites or Co-requisites:** None
 - c. **Indicate whether a required, elective, or selected elective:** Required
6. **Specific Goals for the Course**
 - a. **Specific Outcomes of instruction:** In this class, we will teach you about how computer scientists organize the world and talk about computers. We will teach you the computational approach to dealing with problems using the following steps:
 - Learn to take a systematic approach to problem solving and to formulate algorithms and strategies with a computational approach.
 - To understand the form and function of computer programming languages.
 - To know the steps in a software development process.
 - To understand programs following the input, process, output (IPO) pattern.
 - Understand how computing and computational processes interact with the world at large.
 - Apply computational knowledge to the analysis of current events and innovations.
 - Understand and be able to articulate problems that computer scientists study at a high level.
 - b. **Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course:** Outcome 1, Analyze a complex computing problem and to apply principles of computing and other relevant disciplines to identify solutions; Outcome 2, Design, implement, and evaluate a computing-based solution to meet a given set of computing requirements in the context of the program's discipline; Outcome 3, Communicate effectively in a

variety of professional contexts; Outcome 6, Apply computer science theory and software development fundamentals to produce computing-based solutions.

7. Brief list of topics to be covered:

- Programming
 - Print / input functions
 - Data types, variables
 - Functions, parameters, returns
 - Iteration
 - Lists
 - Booleans, conditionals
 - File input / output
 - Using modules and libraries
 - Using objects in programs
- Computing in the World
 - User tracking and privacy
 - Data and scale
 - Data visualization
 - Artificial intelligence
 - Algorithmic bias
- Computer Science
 - Searching
 - Sorting Runtime
 - Graphs
 - Classic Computer Science Problems

CVEN 1027 Course Syllabus

1. **Course number and name:** CVEN 1027, Civil Engineering Drawing
2. **Credits, contact hours, and categorization of credits in Table 5-1:** 3 credits, 3 contact hours, engineering topics
3. **Instructor's or course coordinator's name:** Jeremy Andryauskas
4. **Textbook:** AutoCAD and Its Applications, Schumaker/Madsen, 2020; AutoCAD Civil 3D 2016 Essentials, Chappell, 2016
5. **Specific course information:**
 - a. **Brief description of the content of the course (catalog description):** Develops drawing and drafting skills for civil engineering projects with software tools. Students will learn to read and interpret design and construction drawings.
 - b. **Prerequisites or co-requisites:** None.
 - c. **Indicate whether a required, elective, or selected elective:** Required
6. **Specific goals for the course:**
 - a. **Specific outcomes of instruction:** The student, upon completion of this course, should be able to demonstrate basic civil engineering modeling skills using AutoCAD and AutoCAD Civil 3D, adhering to common industry CADD and design standards. In addition to modeling a design concept, the student should be able to develop construction plans and graphical representations of the design that are expressed in a professional manner.
 - b. **Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.** Outcome 3, An ability to apply oral communications to communicate effectively with a range of audiences.
7. **Brief list of topics to be covered:** Introduction to AutoCAD, AutoCAD 2D drawing and editing, AutoCAD 3D drawing and editing, Drafting CADD Standards, Civil Engineering Documentation, Introduction to AutoCAD Civil 3D, Land Survey data types, Terrain Surfaces, Existing and Design, Horizontal alignment design, Vertical alignment design, Subsurface pipe networks, Terrain grading tools

CVEN 1317 Course Syllabus

1. **Course number and name:** CVEN 1317 Introduction to Civil and Environmental Engineering
2. **Credits, contact hours, and categorization of credits in Table 5-1:** 1 credit, 1 contact hour / week, engineering topic
3. **Instructor:** Angela R. Bielefeldt, Ph.D., P.E.
4. **Textbook:** Chapters from: *Introduction to Infrastructure: An Introduction to Civil and Environmental Engineering*. Penn, M.R., and P.J. Parker. 2011.
 - a) other supplemental materials
 - *Envision: Sustainable Infrastructure Framework Guidance Manual*. Version 3. ISI.
 - ASCE Code of Ethics. 2020.
 - G. Madhavan. 2022. The Grind Challenges. *Issues in Science and Technology*. Vol 38 (4), 17-19.
 - ASCE Future World Vision, website
 - DEI readings / videos, including: NSPE *Why Should I care about diversity in engineering?* July/August 2020
5. **Specific course information:**
 - a. **Brief description of the content of the course (catalog description):** Surveys the broad subject of civil and environmental engineering and professional practice. Includes the subdisciplines of structures, water resources, geotechnics, transportation, environment, and construction. Discusses professional ethics, important skills for engineers, and the engineering design process as it fulfills multiple objectives.
 - b. **Prerequisites or co-requisites:** none
 - c. **Indicate whether a required, elective, or selected elective:** Required
6. Specific goals for the course
 - a. Specific outcomes of instruction: At the end of this course students can:
 - describe what civil engineering is, what they may do as a civil engineer, the skills required to be a civil engineer, and similarities and differences compared to other engineering majors
 - describe the process to gain the skills required to be a civil engineer and successfully graduate with a degree in civil engineering from CU
 - describe the ethical behavior expected of civil engineers
 - define sustainability and describe its importance to civil engineering
 - explain the importance of professional licensure (PE) for civil engineers
 - b. **Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course:** Outcome 4, an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.

7. Brief list of topics to be covered: Overview of civil engineering: infrastructure & CE skills, Engineering Design, Engineering Ethics, Sustainable Engineering; Diversity, equity, and inclusion (DEI); Data Science; Creativity and innovation; Team bridge project: use bridge design software; consider technical elements (deflection), cost, environmental impacts, social impacts, and creativity; Sub-disciplines in civil engineering: structures, geotechnical, construction, water resources, environmental, transportation; Guest speakers: working as a civil engineering; CU civil engineering curriculum, co-curricular activities, internships, research; Path to professional licensure and its importance

CVEN 2012 Course Syllabus

1. **Course number and name:** CVEN 2012 Introduction to Geomatics
2. **Credits, contact hours, and categorization of credits in Table 5-1:** 3 credits, 3.5 contact hours, engineering topic
3. **Instructor:** Christopher Senseney, PhD, P.E.
4. **Textbook:** Elementary Surveying: An Introduction to Geomatics, 15th Edition, Charles D. Ghalani, Pearson, New York, 2018.
5. **Specific course information:**
 - a. **Brief description of the content of the course (catalog description):** Presents basic techniques of land and construction surveying, including measurement of position, elevation, orientation and length of lines, area, volume and layout calculations. Optical, GPS and GIS equipment and methods included.
 - b. **Prerequisites or co-requisites:** none
 - c. **Indicate whether a required, elective, or selected elective:** required
6. **Specific goals for the course:**
 - a. **Specific outcomes of instruction:**
 - Design and acquire field survey measurements using modern surveying instruments.
 - Process survey measurements to produce plans showing features and contours of appropriate accuracy and visual representation.
 - Understand the processes involved in representing the contiguous real world in an abstracted form.
 - Understand the types of errors typically encountered in field surveys and how to account for these errors in calculations based on observations.
 - Demonstrate teamwork and leadership skills within survey teams.
 - b. **Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course:** Outcome #6, An ability to analyze and interpret data, and use engineering judgment to draw conclusions. Course aligns with Outcome #5, Ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks and meet objectives.
7. **Brief list of topics to be covered:** Significant digits, Rounding, Error and error propagation, Differential leveling and misclosure, Horizontal and vertical angles, Distance measurements, Azimuths and coordinates, Theodolite/Total Station traverses, Conformal coordinate transformations, Spheroid, ellipsoid, and geoid depictions of the Earth, Global Navigation Satellite Systems, Topographic maps, Civil 3D

CVEN 2017 Course Syllabus

1. **Course number and name:** CVEN 2017 Excel Matlab R Primer
2. **Credits, contact hours, and categorization of credits in Table 5-1:** 1 credit, 1 contact hour, engineering topic
3. **Instructor or Course Coordinator Name:** Yu-Hsuan Lee
4. **Textbook:** N/A
 - a. other supplemental materials – course lecture notes written by the instructor
5. **Specific course information:**
 - a. **Brief description of the content of the course (catalog description):**
Introduction to basic usage of Excel, Matlab and R software programs. Includes overview of fundamental operations such as data input and output, arithmetic, graphics, and programming syntax; more specific operations such as algebraic functions, linear algebra, plotting, loops, conditional statements, statistics and data analysis. Students will complete a final programming project with one of the software programs.
 - b. **Prerequisites or Co-requisites:** Pre-Requisite: CSCI 1200 Introduction to Computational Thinking
Recommended Co-Requisite: APPM 2360 Introduction to Linear Algebra & Diff. Equations
 - c. **Indicate whether a required, elective, or selected elective:** Required
6. **Specific goals for the course:**
 - a. **Specific Outcomes of instruction:** Students will gain the skills required for basic problem solving and typical applications in engineering using all three software programs, finishing the course with sufficient fluency to make further advances on their own.
 - b. **Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course:** Outcome 6, An ability to analyze and interpret data, and use engineering judgment to draw conclusions.
7. **Brief list of topics to be covered:** Overview of software programs, Basic architecture and purpose of the three software, with attention to common properties and differences; Fundamental operations, including data input and output, basic computation, and graphics. Overview of built-in high level operations and basic syntax of programming; Specific operations, including algebraic functions, linear algebra, plotting, loops, conditional statements, statistics and data analysis; Problem solving projects: students choose from a range of problems in engineering.

CVEN 2121 Course Syllabus

1. **Course number and name:** CVEN 2121: Analytical Mechanics I (Statics)
2. **Credits, contact hours, and categorization of credits in Table 5-1:**
3 Credits, 3 contact hours, Engineering topic
3. **Instructor's or course coordinator's name:** Jeong-Hoon Song
4. **Textbook:** Engineering Mechanics-Statics, R. C. Hibbeler, 14th Edition
5. **Specific course information:**
 - a. **Brief description of the content of the course (catalog description):** Applies mechanics to the study of static equilibrium of rigid and elastic bodies. Includes composition/resolution of forces; moments/couples; equivalent force systems; free-body diagrams; equilibrium of particles and rigid bodies; forces in trusses/beams; frictional forces; first/second moments of area; moments and products of inertia.
 - b. **Prerequisites or Co-requisites:** PHYS 1110 (min grade C-) / APPM 2350 or MATH 2400 (min grade C-)
 - c. **Indicate whether a required, elective, or selected elective:** Required
6. **Specific goals for the course:**
 - a. **Specific Outcomes of instruction:**
The following course objectives are met by this course:
 - an ability to apply knowledge of mathematics, science, and engineering
 - an ability to identify, formulate, and solve engineering problems
 - an ability to communicate effectively through writing and drawings
 - b. **Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course:** Outcome 6, An ability to analyze and interpret data, and use engineering judgment to draw conclusions.
7. **Brief list of topics to be covered:** Mechanics, Fundamental Concepts, Unit of Measurement, Force Vectors, Equilibrium of a Particle, Force System Resultants, Equilibrium of a Rigid Body, Structural Analysis, The method of Sections, Space Trusses, Frames and Machines, Internal Forces, Characteristics of Dry Friction, Center of Gravity and Centroid, Moments of Inertia

CVEN 3111 Course Syllabus

1. **Course number and name:** CVEN 3111, Analytical Mechanics II (Dynamics)
2. **Credits, contact hours, and categorization of credits in Table 5-1:** 3 credits, 3 contact hours, engineering topic
3. **Instructor:** Fatemeh Pourhamadian, Ph.D.
4. **Textbook:** Engineering Mechanics - Dynamics (14th ed.) by R. C. Hibbeler
5. **Specific course information:**
 - a. **Brief description of the content of the course (catalog description):** Studies the motion (kinematics) of particles and rigid bodies, and the forces that cause the motion (kinetics). Newton's laws as well as energy methods are used to study the motion of particles and rigid bodies in two and three dimensions.
 - b. **Prerequisites or Co-requisites:** CVEN 2121
 - c. **Indicate whether a required, elective, or selected elective:** Required course
6. **Specific goals for the course:**
 - a. **Specific outcomes of instruction:** Dynamics is essentially advanced mechanics based on Newtonian physics. This topic includes the motion (kinematics) of particles and rigid bodies and the forces that cause the motion (kinetics). Newton's laws as well as energy methods are used to study the planar motion of particles and rigid bodies.
 - b. **Explicitly indicate which of the student outcomes listed in criterion 3 are addressed by the course:** Outcome 1, Ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
7. **Brief list of topics to be covered:** The physical concept, problem-solving method, and intricate details of algebra, geometry, trigonometry, and/or vector analysis. As engineers, part of our role is to communicate our knowledge, analysis, and results in a way that can be understood by others. Rectilinear Kinematics General Curvilinear Motion, Motion of a Projectile, Curvilinear Motion: Normal-Tangential & Cylindrical Components, Absolute Dependent Motion Analysis of Two Particles, Relative-Motion of Two Particles Using Translating Axes, Newton's Second Law of Motion, The Equation of Motion, Equation of Motion for a System of Particles, Equations of Motion in Curvilinear Coordinates, Principle of Work and Energy, Principle of Work and Energy for a System of Particles, Power and Efficiency, Conservative Forces and Potential ^[1]_[SEP]Energy, Conservation of Energy, Principle of Linear Impulse and ^[1]_[SEP]Momentum, Principle of Linear Impulse and Momentum ^[1]_[SEP]for a System of Particles, Conservation of Linear Momentum for a ^[1]_[SEP]System of Particles, Impact, Angular Momentum, Relation Between Moment of a Force and Angular Momentum ^[1]_[SEP], Principle of Angular Impulse and Momentum, Planar Rigid-Body Motion, Translation, Rotation about a Fixed Axis, Absolute Motion Analysis, Relative-Motion Analysis: Velocity, Instantaneous Center of Zero Velocity, Relative-Motion Analysis: Acceleration, Mass Moment of Inertia, Planar Kinetic Equations of Motion

CVEN 3161 Course Syllabus

1. **Course number and name:** CVEN 3161, Mechanics of Materials I
2. **Credits, contact hours, and categorization of credits in Table 5-1:**
3 credits, 3 hours per week, engineering topics
3. **Instructor's or course coordinator's name:** Yunping Xi
4. **Textbook:** Roy R. Craig, Jr. (2011) "Mechanics of Materials", 3rd Edition, John Wiley & Sons, New York.
5. **Specific course information:**
 - a. **Brief description of the content of the course (catalog description):** Addresses concepts of stress and strain; material properties, axial loading, torsion, simple bending, and transverse shear; analysis of stress and strain; and deflections of beams. Includes selected experimental and computational laboratories.
 - b. **Prerequisites or Co-requisites:** Requires prereq [CVEN 2121](#) or [GEEN 2851](#) or [ASEN 2001](#) or [MCEN 2023](#) (all min grade C-). Requires coreq [APPM 2360](#) or ([MATH 2130](#) 3430). Restricted to Arch (AREN) or Civil (CVEN) or Environ (EVEN) or Integ Design (IDEN) majors with a CIV, ENR or ARC subplan
 - c. **Indicate whether a required, elective, or selected elective:** Required
6. **Specific goals for the course:**
 - a. **Specific outcomes of instruction:** Students will be able to conduct structural analyses (stress, strain, and deformations) of simple structural members under various loadings including tension/compression, torsion, bending and shear.
 - b. **Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course:** Outcome 3, Ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics; Outcome 6, An ability to develop and conduct appropriate experimentation and An ability to analyze and interpret data, and use engineering judgment to draw conclusions.
7. **Brief list of topics to be covered:** Deformable bodies, Equilibrium equations, Free body diagrams, Normal stress and normal strain, Shear stress and shear strain, General definitions of stress and strain, Mechanical properties of materials, Stress-strain diagrams, Hooke's law, Generalized Hooke's law, Basic mechanical properties, Tension and compression, Elastic behaviors of axially loaded members, and temperature effect, Inelastic behaviors, Torsion of circular bars, Linear elastic torsion of circular bars, Inelastic torsion of circular bars, Bending and shear, Equilibrium in beams, Shear force diagrams and bending moment diagrams, Flexural stress in linear elastic beams, Shear stress in beams, Differential equations of beams, Deflection of beams, Inelastic beam analyses, Transformations of stress and strain, Principal stresses and principal strains, Mohr's circle for stress and strain transformation

CVEN 3227 Course Syllabus

1. Course number and name: CVEN 3227 Probability, Statistics and Decision for Civil Engineers

2. Credits, contact hours, and categorization of credits in Table 5-1: 3 credits, 3 contact hours, engineering topics

3. Instructor: Professor Cristina Torres-Machi

4. Textbook: Probability Concepts in Engineering, Alfredo H-S. Ang and Wilson H. Tang (2006)

5. Specific course information:

- a. **Brief description of the content of the course (catalog description):** content of the course: Introduces uncertainty based analysis concepts and applications in the planning and design of civil engineering systems emphasizing probabilistic, statistics, and design concepts and methods
- b. **prerequisites or Co-requisites:** Junior standing
- c. **Indicate whether a required, elective, or selected elective:** Required

6. Specific goals for the course:

a. specific outcomes of instruction:

By the completion of this course, you should be able to:

- Explain concepts, methods and models related to probability applications in civil engineering and compute event probabilities
- Apply statistical methods to (a) summarize properties of a data set, (b) fit probability distributions or regression models to data and (c) conduct hypothesis testing
- Critically evaluate data and statistics from applications in civil engineering research and applications and their implications

b. Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course: Outcome 1, an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics; Outcome 6, An ability to analyze and interpret data, and use engineering judgment to draw conclusions

7. Brief list of topics to be covered: Probability and Descriptive Statistics, Methods for Prediction, Decision Analysis

CVEN 3246 COURSE SYLLABUS

1. **Course number and name:** CVEN 3246 Introduction to Construction
2. **Credits, contact hours, and categorization of credits in Table 5-1** Three (3) credits, 3 contact hours, engineering topic
3. **Instructor/Course Coordinator name:** Matt Morris
4. **Textbook:** No textbook required
5. **Specific course information:**
 - a. **Brief description of the content of the course (catalog description):** Provides a broad view of concerns, activities, and objectives of people involved in construction: the owner, architect/engineer, contractor, labor and inspector. Interactive gaming situation relates these people to the construction contract, plans/specifications, estimates/bids, scheduling, law and financial management.
 - b. **Prerequisites or Co-requisites:** No pre-requisites
 - c. **Indicate whether a required, elective, or selected elective:** Required
6. **Specific goals for the course:**
 - a. **Specific outcomes of instruction:**
 - Describe the roles of key project players
 - Evaluate and select an appropriate project delivery method for a construction project
 - Estimate the cost of a basic structure or earthwork project
 - Calculate the equivalence of a series of economic investments
 - Schedule a series of construction tasks using the critical path method
 - Establish a project cash flow projection
 - Identify the requisite elements of a contract
 - Identify and analyze project risks
 - Identify and assess safety hazards on construction projects
 - b. **Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course:** Outcome 1, Ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics; Outcome 5, Ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks and meet objectives.
7. **Brief list of topics to be covered:** Project key players, Delivery Systems, Procurement Methods, Master Planning, Project Planning, Cost Estimating fundamentals, Scheduling fundamentals, Estimating earthwork, Insurance and Bonds, Risk , Contracts, Engineering Econ

CVEN 3256 Course Syllabus

- 1) **Course number and name:** CVEN 3256 – Construction Equipment and Methods
- 2) **Credits, contact hours, and categorization of credits in Table 5-1:** 3 credits, 3 contact hours, engineering topic
- 3) **Instructor:** Dr. Sid Bhandari
- 4) **Textbook:** None
- 5) **Specific course information:**
 - a) **Brief description of the course (catalog description):** Integrated study of construction equipment, methods, and economics. Topics include equipment productivity, equipment selection, and construction engineering design within economic constraints. Examples include earthmoving, concrete formwork, and temporary construction.
 - b) **Prerequisites or Co-requisites:** Requires prerequisite course of CVEN 3246 (minimum grade C-). Restricted to Architectural (AREN) or Civil (CVEN) or Integrated Design (IDEN) Engineering majors only.
 - c) **Indicate whether a required, elective, or selected elective:** Selected elective
- 6) **Specific goals for the course:**
 - a) **Specific outcomes of instruction:** By the end of this course students will be able to:
 - Design an earthwork operation including analysis of compaction, ripping, clearing and dozing of soil
 - Learn to use different job hazard analysis techniques used for a construction operation
 - Select and design appropriate excavation support systems
 - Design a formwork system
 - Design scaffolding and shoring
 - Design a blasting operation
 - Identify and analyze basic risks and biases
 - b) **Explicitly state which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course:** Outcome 1, Ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics; Outcome 2, apply engineering design to produce solutions that meet specific needs with consideration of public health, safety, and welfare, global, cultural, social, environmental, and economic factors
- 7) **Brief list of topics to be covered:** Dozing operations, Soil properties and compaction operations, Blasting operations, Economics multifactor, Equipment in utility sector, Support system selection, Active-Passive soil pressure, Excavation operation, Different types of formwork, Designing elevated wall, bracing, Dewatering, Scaffolding design, Pipeline construction fundamentals, Risk management, Equipment and technological upgrades, Human factors in decision making, Science of safety: hazards and controls

CVEN 3313 Course Syllabus

1. Course number and name: CVEN 3313 – Theoretical Fluid Mechanics

2. Credits, contact hours, and categorization of credits in Table 5-1:

3 credits, 4 contact hours (3 hours of lecture + 1 hour of recitation), engineering topic.

3. Instructor: Professor Michael Gooseff

4. Textbook: Munson, Young, and Okiisi's Fundamentals of Fluid Mechanics, 9th Edition, by AL Gerhart, JI Hochstein, and PM Gerhart, 2021, Wiley. (online e-book)

5. Specific course information:

a. **Brief description of the content of the course (catalog description):** Basic principles of fluid mechanic. Covers fluid properties, hydrostatics, fluid flow concepts, including continuity, energy, momentum, dimensional analysis and similitude and flow in closed conduits.

b. **Prerequisites or Co-requisites:** CVEN 2121 (Analytical Mechanics 1) or GEEN 2851 or ASEN 2001 or MCEN 2023 (all require minimum of C-)

c. **Indicate whether a required, elective, or selected elective:** Required

6. Specific goals for the course:

a. **Specific outcomes of instruction:**

- The student should be able to explain the concepts of hydrostatics.
- The student should be able to explain the significance of the Bernoulli equation of energy conservation.
- The student should be able to explain energy losses in pipe flow systems.
- explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.

b. **Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course:** outcome 1, Ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

7. Brief list of topics to be covered: Fluid Statics, Buoyancy, Stability, Bernoulli Equation, Total Energy Equation including losses, Hydraulic Grade Lines; Energy Grade Lines, Dimensional Analysis, Modeling & Similitude, Momentum, Viscous flow in pipes

CVEN 3323 Course Syllabus

1. Course number and name: CVEN 3323, Hydraulic Engineering

2. Credits, contact hours, and categorization of credits in Table 5-1: 3 credit hrs, 3 lecture hrs with a lab component, Engineering Topics

3. Instructor's or course coordinator's name: Professor Roseanna M. Neupauer

4. Textbook: Houghtalen, A.O. Akan, and N.H.C. Hwang, Pearson, 2017. ISBN-13: 978-0-13-429238-0; ISBN-10: 0-13-429238-3.

5. Specific course information

- a. **Brief description of the content of the course (catalog description):**
Studies hydraulic engineering theory and applications. Topics include incompressible flow in conduits, pipe system analysis and design, open channel flow, flow measurement, analysis and design of hydraulic machinery.
- b. **prerequisites or co-requisites:** CVEN 3313 Theoretical Fluid Mechanics, or equivalent.
- c. **indicate whether a required, elective, or selected elective:** Required

6. Specific goals for the course

- a. **Specific outcomes of instruction** After completing this course, you will be able to
 - Analyze flow in pipe systems and open channels using conservation of mass, momentum, and energy. You will gain knowledge of applying fundamentals of fluid mechanics for analysis and design of flow through closed conduits, pumps, and open channels.
 - Route flows through hydraulic structures. You will route flows through hydraulic structures (e.g. weirs, pipes).
 - Observe and analyze features related to flow through hydraulic systems. Through the labs associated with the class, you will gain knowledge on conducting experiments and interpreting the observed data for various phenomena relating to flow through conduits and open channels.
 - Design a water distribution system. Through the class project, you will gain knowledge on designing various components of water distribution systems.
 - Solve pipe flow problems using hydraulic engineering software. You will use EPANET for pipe network design.

b. Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course. Outcome 1, an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics; Outcome 2, apply engineering design to produce solutions that meet specific needs with consideration of public health, safety, and welfare, global, cultural, social, environmental, and economic factors; Outcome 3, communicate effectively with a range of audiences; Outcome 4, recognize ethical and professional responsibilities and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts; Outcome 5, function effectively on a team whose members together provide leadership,

create a collaborative and inclusive environment, establish goals, plan tasks, meet objectives; Outcome 6, develop and conduct appropriate experimentation, analyze & interpret data, use engineering judgment to draw conclusions

7. **Brief list of topics to be covered:** Fluid properties, Error propagation, measurement uncertainty, Hydrostatic pressure, head and force, Conservation of mass, momentum, and energy, Energy losses in pipes, Pipe flow problems, Single pipe – determine head loss, determine flow rate, choose diameter, Pipes in series, Pipes in parallel, Pipe networks, Three-reservoir problem, Empirical equations, Centrifugal pumps, pump selection and design, Net positive suction head, Open channel flow, Uniform flow, Flow over weirs, Specific energy, Gradually varied flow, Hydraulic jumps, Hydraulic elements

CVEN 3414 Course Syllabus

1. Course number and name: CVEN 3414: Fundamental of Environmental Engineering

2. Credits, contact hours, and categorization of credits in Table 5-1: 3 credits hours, 3 contact hours, engineering topics

3. Instructor name: Prof. Sheldon V. Masters

4. Textbook: Masters, G.M., Ela, W.P., Introduction to Environmental Engineering and Science, 3rd Edition Prentice Hall, 2008.

a. Supplemental Readings/Materials Lecture notes, handouts and assignments will be supplied by the instructor when appropriate. These materials will be posted on Canvas, accessible to all students enrolled in the course.

5. Specific Course Information

a. Brief description of the content of the course (catalog description): The course will examine key concepts in water pollution, air pollution, hazardous wastes, environmental legislation, and global atmospheric change. This broad survey will aid your understanding of the interesting and complex environmental topics that are regularly “in the news”. The course is valuable as a prerequisite to more advanced courses in environmental engineering, as a technical education for the general citizen and interested students outside of engineering, and as an introduction to environmental constraints that are increasingly important to other engineering disciplines.

b. Prerequisites or Co-requisites: To take CVEN 3414, you need a year of general chemistry (for most of the engineers taking this course, one year of general chemistry is compressed into the one-semester CHEM 1211 General Chemistry for Engineers). You should also be taking or have taken APPM 1360 Calculus 2.

c. Indicate whether a required, elective, or selected elective: Required

6. Specific goals for the course

a. Specific outcomes of instruction

- Recognize the major regulations used to protect air and water quality.
- Evaluate the fate of contaminants in natural and engineered environments using mass balances.
- Utilize simple models (batch, plug flow, complete mix) to describe the fate of contaminants.
- Describe appropriate strategies/technologies to produce high quality drinking water.
- Recommend appropriate strategies/technologies to produce high quality wastewater treatment plant effluents.
- Relate drinking water and airborne contaminant standards to the protection of health using risk assessment protocols.
- Describe the indoor, local, regional and global impacts of air pollution.
- An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of

engineering solutions in global, economic, environmental, and societal contexts.

b. Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course. Outcome 4, An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.”

7. Brief list of topics covered: Environmental Chemistry, Conservation of Mass and Energy, Materials and Energy, Environmental Sustainability/Population growth, World Climate Simulation, Air Quality, Risk Assessment, Water Pollution, Water Treatment, Corrosion and Distribution System Water Quality, Wastewater Treatment, Solid Waste

CVEN 3424 Course Syllabus

- 1) **Course number and name:** CVEN 3424, Water and Wastewater Treatment
- 2) **Credits, contact hours, and categorization of credits in Table 5-1:** 3 credits, 3 contact hours, engineering topic
- 3) **Instructor:** Christian Ley
- 4) **Textbook:** Water and Wastewater Engineering: Design Principles and Practice, 2020. Mackenzie L. Davis
- 5) **Specific course information:**
 - a) **Brief description of the content of the course (catalog description):** Introduces design and operation of facilities for treatment of municipal water supplies and wastewater. Provides an engineering application of physical, chemical, and biological unit processes and operations for removal of impurities and pollutants. Involves an integrated design of whole treatment systems combining process elements.
 - b) **Prerequisites or Co-requisites:** Requires prerequisite course of CVEN 3414 (minimum grade C-).
 - c) **Indicate whether a required, elective, or selected elective:** selected elective
- 6) **Specific goals for the course:**
 - a) **Specific outcomes of instruction:** In practice, engineering calculations like you will solve in Problem Sets are of little use if not presented neatly and clearly. The following requirements are in place for two reasons: 1) they will help you develop good habits for communicating your calculations that will help make you an asset as an intern and ultimately an engineer; 2) They will make your Problem Sets effective study tools when preparing for both the FE and PE exams.
 - Copy down the problem statement before each problem or print and attach a copy of the assigned problem set to the front of your submittal.
 - Use only one side of the paper.
 - All problem sets must be neat and legible, or points will be deducted. A good habit is to re-write your solution after you have solved it:
 - Handwriting must be easily readable, work on it,
 - You may wish to use a straightedge when drawing lines or diagrams,
 - Completely erase any changes; no eraser marks or cross-outs are acceptable.
 - Draw and label the system (if one is not provided)
 - All graphs must be computer generated (e.g. Excel). A separate guideline for graphs will be posted on the class website. Help will be available if you are not familiar with Excel.
 - Box in all final answers.
 - Leave space between problems (2-3 lines).
 - Staple all sheets together.
 - Show your work/calculations or no partial credit will be given.
 - Draw and label the system (if one is not provided).

- Show an example calculation if repeated calculations are made.
- Correct numeric answers with no work to support the answer will receive no credit. (Imagine your boss asking to check your design calculations and you not being able to provide any)
- Show the formula and an example calculation if spreadsheets are used.
- List all assumptions not stated in the problem.
- Reference any equations used (e.g. Cooper 6.20; FE pg. 183; Lecture 7 notes)
- Reference any information (data) used from non-class sources if used (e.g. the internet, other textbooks)
- All answers must be clear as MUD – Magnitude, Units, and Direction. The magnitude is meaningless without units. Any time a vector is being reported, the direction is also required (often just a plus or minus sign in this class).
- Use appropriate significant figures. For this class, three is typically appropriate (e.g., 3.23, 0.0323, 32,300 or 3.23×10^6).

b) **Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.** Outcome 1, Ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. Outcome 2, apply engineering design to produce solutions that meet specific needs with consideration of public health, safety, and welfare, global, cultural, social, environmental, and economic factors

7) **Brief list of topics to be covered:** Drinking Water Overview & Regs., Coagulation chemistry, Mixing theory, Coagulation design, Mixing practice, Rapid mix design, Flocculation design, Sedimentation theory, Sedimentation practice, Sedimentation basic design, Granular filtration, Rapid media filtration theory, Rapid media filtration practice, Membrane filtration, Slow sand and riverbank filtration, Disinfection theory and practice, Disinfection design, Plant coordination and layout, Wastewater overview, Wastewater characteristics and regs., Preliminary and primary treatment, Wastewater microbiology, Activated sludge theory, Activated sludge design, Secondary clarification/Activated sludge mods, Disinfection/Breakpoint chlorination, Nutrient removal theory, Nutrient removal design, Oxygen transfer, Thickening digestion and dewatering, Attached growth processes, Small systems alternatives to activated sludge, Natural treatment systems, precipitative softening, Air stripping, Activated carbon adsorption, High pressure membranes

CVEN 3525 Course Syllabus

1. Course number and name: CVEN 3525: Structural Analysis
2. Credits, contact hours, and categorization of credits in Table 5-1:
3 Credits, 3 contact hours, Engineering topic
3. Instructor's or course coordinator's name: Jeong-Hoon Song
4. Textbook: Structural Analysis, R. C. Hibbeler, 10th Edition.
5. Specific course information:
 - a. **Brief description of the content of the course (catalog description):** Studies structural analysis of statically determinate and indeterminate systems, deflections, energy methods, and force and stiffness methods.
 - b. **Prerequisites or co-requisites:** CVEN 3161 or MCEN 2063 (min grade C-)
 - c. **Indicate whether a required, elective, or selected elective:** Required
6. Specific goals for the course
 - a. Specific outcomes of instruction:
The following course objectives are met by this course:
 - an ability to apply knowledge of mathematics, science, and engineering
 - an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
 - an ability to communicate effectively through writing and drawings
 - an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
 - b. Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course: Outcome 1, Ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
7. Brief list of topics to be covered: Types of structures and loads, analysis of statically determinate structures, analysis of statically determinate trusses, internal loadings, deflections, energy methods: deflections, force method: statically indeterminate structures, displacement method: slope-deflection equations, stiffness method: truss analysis, stiffness method: beam analysis, stiffness method: plane frame analysis

CVEN 3698 Course Syllabus

1. **Course number and name:** CVEN 3698, Engineering Geology
2. **Credits, contact hours, and categorization of credits in Table 5-1:** 3 credits, 3 contact hours, basic science
3. **Instructor's or course coordinator's name:** Dr. Bernard Amadei
4. **Textbook:** West & Shakkor "Geology Applied to Engineering"
5. **Specific course information:**
 - a. **Brief description of the content of the course (catalog description):** Highlights the role of geology in engineering minerals; rocks; surficial deposits; rocks and soils as engineering materials; distribution of rocks at and below the surface; hydrologic influences; geologic exploration of engineering sites; geologic hazards; mapping; and geology of underground excavations, slopes, reservoirs and dam sites.
 - b. **Prerequisites or co-requisites:** requires pre-requisite or co-requisite of CVEN 2121, Analytical Mechanics 1
 - c. **Indicate whether a required, elective, or selected elective:** Required
6. **Specific goals for the course:**
 - a. **Specific outcomes of instruction:**
 - an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
 - an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
 - an ability to communicate effectively with a range of audiences
 - an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
 - an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
 - an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
 - an ability to acquire and apply new knowledge as needed, using appropriate learning strategies
 - b. **Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course:** Outcome 1, An Ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

7. **Brief list of topics to be covered:** Engineering geology as an interdisciplinary field, Planet Earth and its population, Geologic hazards and resilience to hazards, Minerals and their engineering properties, Igneous Rocks: geologic classification, Engineering properties of plutonic rocks, Engineering properties of volcanic rocks, Sedimentary Rocks: geologic classification, Engineering properties of shales, sandstones, etc., Engineering properties of soluble rocks, Metamorphic Rocks: geologic classification, Engineering properties of metamorphic rocks, Fundamentals of structural geology, Distribution of rocks at and below the surface, Processes, soils and soil properties, Exploration of an engineering site, Computational engineering geology

CVEN 3708 Course Syllabus

1. **Course number and name:** CVEN 3708, Geotechnical Engineering I
2. **Credits, contact hours, and categorization of credits in table 5-1:** 3 credits, 4 contact hours (lecture+lab), engineering topic
3. **Instructor:** Shideh Dashti, Ph.D.
4. **Textbook:** Donald Coduto, Man-Chu Ronald Yeung, and William A. Kitch (2010). "Geotechnical Engineering: Principles & Practices." 2nd Edition. Prentice Hall.
5. **Specific course information:**
 - a. **Brief description of the content of the course (catalog description):** Covers basic engineering characteristics of geological materials; soil and rock classifications; site investigation; physical, mechanical, and hydraulic properties of geologic materials; the effective stress principle; soil and rock improvement; seepage analysis; stress distribution; and consolidation and settlement analyses. Selected experimental and computational laboratories
 - b. **Prerequisites or co-requisites:** CVEN 3161: mechanics of materials
 - c. **Indicate whether a required, elective, or selected elective:** Required
6. **Specific goals for the course:**
 - a. **Specific outcomes of instruction:**
 - Ability to classify soils based on laboratory test results
 - You will gain knowledge of the nature of soils and use it for their classification for engineering applications. (This objective maps to ABET outcomes "a", "b", "d" and "g".)
 - Ability to develop and apply knowledge of phase relations in soils to solve basic mass-volume problems in geotechnical and construction engineering
 - You will gain knowledge of the different phases of soil constituents and express it in mass-volume relations. (This objective maps to ABET outcome "a".)
 - Ability to apply theory of compaction and measured soil compaction test to plan a soil compaction program in the field
 - You will gain knowledge on densification of soils through the different compaction techniques and its relation to moisture content. (This objective maps to ABET outcomes "a", "d" and "g".)
 - Ability to apply data from permeability tests to analyze seepage through earth structures
 - You will gain knowledge on the flow of water through porous soils and apply seepage theory to analyze flow through earth structures. You will also learn to apply seepage theory to groundwater hydrology. (This objective maps to ABET outcomes "a", "b", "c", "e" and "g".)
 - Ability to calculate the stress distribution under applied foundation loads to evaluate settlement of foundations

- You will gain knowledge on the theory of stress distribution and apply it to obtain the stresses in the foundation soil due to different boundary loads. (This objective maps to ABET outcomes "a", and "e".)
- Ability to apply knowledge of soil compressibility obtained from oedometer testing to calculate settlement of foundations
- You will gain knowledge on the soil compressibility and study it by oedometer testing. You will then apply this knowledge to the calculation of surface settlement due to the compressibility of the underlying soils. (This objective maps to ABET outcomes "a", "b", "d" and "e".)
- Ability to apply theory of consolidation and measured consolidation data to predict the time rate of settlement
- You will gain knowledge of effective stresses and to apply it in developing a theory of consolidation. You will then apply the theory to conduct and analyze consolidation testing, and to analyze consolidation settlement. (This objective maps to ABET outcomes "a", "b", "d" and "e".)

b. Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course: Outcome 5, Ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks and meet objectives; Outcome 6, An ability to develop and conduct appropriate experimentation

- 7. Brief list of topics to be covered:** Introduction to geotechnical engineering, grain size distributions, mass-volume relationships for soils, index properties and soil classification, compaction of soils, permeability of soils, seepage in earth structures, capillarity and unsaturated soils, stress distribution, effective stress, compression of soils, time rate of consolidation, applications

CVEN 3718 Course Syllabus

- 1) **Course number and name:** CVEN 3718, Geotechnical Engineering 2
- 2) **Credis, contact hours, and categorization of credits in Table 5-1:** 3 credits, 4 contact hours (lecture + lab), engineering topic
- 3) **Instructor:** Dr. Yida Zhang
- 4) **Textbook:** Coduto, Donald P., Yeung, Man-Chu Ronald, and Kitch, William A. Geotechnical Engineering: Principles & Practices. 2nd edition. Prentice Hall. 2011.
 - a) Other supplemental materials:
 - Holtz, Robert D., Kovacs, William D., and Sheahan. An Introduction to Geotechnical Engineering, 2nd edition, Prentice Hall, 2010.
 - Das, Braja M., Sobhan, Khaled. Principles of Geotechnical Engineering, 9th edition, Cengage Learning, 2018.
 - Bardet, J.P. Experimental Soil Mechanics, Prentice Hall, 1997.
- 5) **Specific course information:**
 - a) **Brief description of the content of the course (catalog description):** Covers stress analysis and plastic equilibrium, shear strength of soil, bearing capacity, lateral earth pressures, slope stability and underground construction. Analysis and design of shallow and deep foundations, retaining walls and other earth and rock structures. Selected experimental and computational laboratories.
 - b) **Prerequisites or Co-requisites:** Requires prerequisite course of CVEN 3708 (minimum grade C-). Restricted to College of Engineering majors only.
 - c) **Indicate whether a required, elective, or selected elective:** selected elective
- 6) **Specific goals for the course:**
 - a) **Specific outcomes of instruction:** To learn the fundamental principles of soil mechanics and laboratory testing. To apply them to the design of geotechnical structures, such as retaining walls, slopes, and foundations.
 - b) **Explicitly state which of the outcomes listed in Criterion 3 or any other outcomes are addressed by the course:** Outcome 1, Ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. Outcome 2, apply engineering design to produce solutions that meet specific needs with consideration of public health, safety, and welfare, global, cultural, social, environmental, and economic factors. Outcome 6, An ability to develop and conduct appropriate experimentation and An ability to analyze and interpret data, and use engineering judgment to draw conclusions
- 7) **Brief list of topics to be covered:** Intro and review of Geotech 1, Stress analysis in soils, Shear strength, Lateral earth pressures and retaining structures, Centrifuge principles, Stability of slopes, Bearing capacity

CVEN 4333 Syllabus

- 1) **Course number and name:** CVEN 4333, Engineering Hydrology
- 2) **Credits, contact hours, and categorization of credits in Table 5-1:** 3 credits, 3 contact hours, engineering topic
- 3) **Instructor:** Nels Bjarke
- 4) **Textbook:** Mays, Water Resources Engineering, third edition.
- 5) **Specific course information:**
 - a) **Brief description of the content of the course (catalog description):** Studies engineering applications of principles of hydrology, including hydrologic cycle, rainfall and runoff, groundwater, storm frequency and duration studies, stream hydrography, flood frequency, and flood routing.
 - b) **Pre-requisites or Co-requisites:** Requires prerequisite course of CVEN 3313 or AREN 2120 or CHEN 3200 or GEEN 3853 or MCEN 3021 (all minimum grade C-). Requires prerequisite or corequisite course of CVEN 3227 or APPM 4570 or MCEN 3047 or MCEN 3208 or CHEN 3010.
 - c) **Indicate whether a required, elective, or selected elective:** selected elective
- 6) **Specific goals for the course:**
 - a) **Specific outcomes of instruction:** The objective of this course is to provide an understanding of the complexity and importance of the movement, distribution, and quality of water, while emphasizing an application to engineering practices. The course studies engineering applications of principles of hydrology, including hydrologic cycle, rainfall and runoff, groundwater, storm frequency and duration studies, stream hydrography, flood frequency, and flood routing
 - b) **Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by this course:** Outcome 1, Ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. Outcome 6, An ability to develop and conduct appropriate experimentation and An ability to analyze and interpret data, and use engineering judgment to draw conclusions
- 7) **Brief list of topics to be covered:** Detailed treatment of aspects of the hydrologic cycle, including: calculating regional water balance, watershed delineation, precipitation, snow, evaporation, infiltration, surface runoff. Also, engineering calculations including design storms, SCS rainfall-runoff relation, unit hydrograph, routing, and basic groundwater flow. Several modules towards the end of the course will reference commonly used hydrologic software such as HEC-HMS and HEC-RAS.

CVEN 4897 Course Syllabus

1. **Course number and name:** CVEN 4897 Professional Issues in Civil Engineering
2. **Credits, contact hours, and categorization of credits in Table 5-1:** 2 credits, 3.0 contact hours, engineering topic
3. **Instructor:** Christopher Senseney, PhD, P.E.
4. **Textbook:** PPI FE Civil Review, 1st Edition - A Comprehensive FE Civil Review Manual, June 15, 2017.
5. **Specific course information:**
 - a. **Brief description of the content of the course (catalog description):** Educates students about the knowledge and skills required for professional civil engineers. Students learn about the path to a professional license, prepare for the FE exam, analyze a situation involving multiple conflicting ethical interests, identify aspects of sustainability in civil engineering projects, and understand the role of project management, public policy, business and public administration, and leadership in civil engineering.
 - b. **Prerequisites or Co-requisites:** restricted to students with 87-180 credits.
 - c. **Indicate whether a required, elective, or selected elective:** Required
6. **Specific goals for the course:**
 - a. **Specific outcomes of instruction:**
 - Explain the importance of professional licensure and the path to become a licensed PE.
 - Explain professional responsibilities relevant to the practice of civil engineering, including safety, legal issues, licensure, credentialing.
 - Recognize ethical responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, societal contexts; apply appropriate reasoning to an ethical dilemma.
 - Apply concepts and principles of sustainability to the solution of complex civil engineering problems.
 - Teamwork and Leadership: function effectively as a leader of team, creating a collaborative and inclusive environment, working with the team to establish goals, plan tasks, and meet objectives; Apply concepts and principles of teamwork and leadership, including diversity and inclusion, in the solutions of civil engineering problems.
 - Explain professional attitudes relevant to the practice of civil engineering, including creativity, curiosity, flexibility, and dependability.
 - Lifelong learning: demonstrate an ability to acquire and apply new knowledge as needed, using appropriate strategies.
 - b. **Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course:** Outcome 4, An ability to recognize ethical and professional responsibilities in engineering situations and

make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.

7. **Brief list of topics to be covered:** Engineering ethics, Leadership in engineering, Contracts and contract law, Professional licensure, Sustainability, Public policy, FE exam review (geotechnical engineering, statics, engineering economics, mechanics of materials, structural analysis, construction engineering, structural design, fluid mechanics, water resources, environmental engineering, dynamics, surveying, probability and statistics, construction materials, transportation engineering)

CVEN 4899 Course Syllabus

1. **Course number and name:** CVEN 4899 Civil Engineering Senior Design
2. **Credits, contact hours, and categorization of credits in Table 5-1:** Four (4) credits, 4 contact hours, engineering topic
3. **Instructor/Course Coordinator:** Matt Morris
4. **Textbook:** No textbook required
5. **Specific course information:**
 - a. **Brief description of the content of the course (catalog description):** Provides a simulated real world design and construction planning experience where teams integrate across multiple civil engineering sub-disciplines to create a solution that satisfies multiple constraints, including design, client requirements, budget, schedule, technical, regulatory, and societal. Final deliverables include: detailed design drawings, specifications, cost estimate, project schedule, construction plan, oral and written presentation.
 - b. **Prerequisites or co-requisites:** (pre-/co-reqs CVEN 3718 and 4728) or (pre-/co-reqs CVEN 3323 and 4333) or (prereqs CVEN 3256 and AREN 4506) or (prereq CVEN 4555 and co-req CVEN 4545) or (pre-/co-req CVEN 3424)
 - c. **Indicate whether a required, elective, or selected elective:** Required
6. **Specific goals for the course:**
 - a. **Specific outcomes of instruction:**
 - Integrate the technical sub-disciplines of structural, geotechnical, water resources and construction to create a professional-level solution to the assigned project problem.
 - Gather relevant data, understand client needs, identify constraints, and identify and use applicable regulations, codes and standards.
 - Create feasible alternative designs and carry out value engineering analysis, including comparison of sustainability and resilience of various alternatives.
 - Prepare increasingly detailed designs and construction planning that satisfies the Owners goals and project's constraints while also conforming to relevant codes and regulations.
 - Prepare design documentation including design rationale and intent, design details and integrated project planning, scheduling and construction cost analysis to support each design stage
 - Complete primary components of contract documents for client as well as basic specifications.
 - Present ideas, concepts and designs in a professional format to the client from the perspective of an engineering firm attempting to win a design-build contract.
 - Work in multi-disciplinary teams and in interdisciplinary formats as appropriate during different phases of the assignment.

- specific outcomes of instruction (e.g. The student will be able to explain the significance of current research about a particular topic.)

b. Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course: Outcome 2, Ability to apply engineering design to produce solutions that meet specified needs and ability to apply engineering design with consideration of safety, social, environmental and economic factors; Outcome 3, An ability to apply oral communications to communicate effectively with a range of audiences and An ability to apply written communications to communicate effectively with a range of audiences; Outcome 4, An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts; Outcome 5, Ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks and meet objectives; Outcome 7, Ability to acquire and apply new knowledge as needed, using appropriate learning strategies

7. **Brief list of topics to be covered:** Water resources, Geotechnical Engineering, Structural Engineering, Construction Engineering and Management, AutoCAD / Civil3D, Team-Building, Public speaking and presentations, Leadership, Ethics, Business relationships and winning work

GEEN 1400 Course Syllabus

1. **Course number and name:** GEEN 1400 Engineering Projects
2. **Credits, contact hours, and categorization of credits in Table 5-1:** 3 credits, 5 contact hours/week, engineering design
3. **Instructor:** Joan Tisdale (Angela Bielefeldt, Mike Soltys, Katherine Ramos, Melissa Davis, Dan Godrick, Malinda Zarske)
4. **Textbook:** *Introductory Engineering Design: A Projects-Based Approach*. Abarca, Javier; Bedard, Al; Carlson, Denise; Carlson, Larry; Hertzberg, Jean; Louie, Bev; Milford, Jana; Reitsma, Rene; Schwartz, Trudy; Sullivan, Jackie. 2000. (Optional)
5. **Specific course information:**
 - a. **Brief description of the content of the course (catalog description):** First-year students solve real engineering design problems in interdisciplinary teams. Design projects vary by section. Curriculum focuses on iterative design process, teamwork and team dynamics, supporting design with testing and analysis, and technical writing. Completed projects are exhibited at an end-of-semester design expo.
 - b. **Prerequisites or co-requisites:** none
 - c. **Indicate whether a required, elective, or selected elective:** Required
6. **Specific goals for the course:**
 - a. **Specific outcomes of instruction:** At the end of this course students can:
 - apply iterative design process to improve design; define functional requirements and specifications; generate alternative design concepts; work within constraints including safety; and appreciate and practice engineering habits of mind (see below).
 - learn and practice effective teamwork skills; learn how to rely on other team members to give and receive help; demonstrate increased understanding of diversity, equity, and inclusion; and practice conflict resolution.
 - develop a professional relationship with an engineering faculty member; develop technical writing and oral presentation skills; effectively communicate final designs to a range of audiences; and learn and practice active listening skills.
 - build hands-on engineering skills for prototyping and manufacturing; practice the role of analysis in the design process; solve engineering problems with appropriate tools; and effectively apply technical skills to produce prototypes/design artifacts that consider a range of economic, environmental, and societal contexts.

- understand the importance of an ethical code for the practice of engineering; appreciate that difficult, ‘gray’ situations arise in engineering practice; and develop an ethical process that will yield appropriate decisions when needed.
- b. **Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course:** Outcome 2, An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors; Outcome 3, an ability to communicate effectively with a range of audiences; Outcome 4, an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts; Outcome 5, an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
7. **Brief list of topics to be covered:** Engineering Design Process, Engineering Tools including Computer Aided Design (CAD), Electronics, Arduino, Laser Cutting, Social Styles/Strengths, Team Dynamics and Growth, Engineering Ethics, Evaluating Design Alternatives, Prototyping, Project Management

PHYS 1110 COURSE SYLLABUS

1. **Course number and name:** PHYS 1110
2. **Credits, contact hours, and categorization of credits in Table 5-1:** 4 credit hours, 4 contact hours, basic science
3. **Instructor's or course coordinator's name:** Two faculty are assigned to this course and the faculty change every semester. In Fall 22, the instructors were Dr. Michael Dubson and Prof. Kathy Perkins. In Spring 23, it was Dr. Daniel Bolton and Prof. Tobin Munsat.
4. **Textbook:** Richard Wolfson, Essential University Physics, Volume 1. (2007). We use the inexpensive eText version which is bundled with the online homework system Mastering Physics.
 - a. other supplemental materials: Online PhET simulations at phet.colorado.edu
5. **Specific course information:**
 - a. **Brief description of the content of the course (catalog description):**
PHYS 1110 (4). General Physics 1. Three lect., one rec. per week, plus three evening exams in the semester. First semester of three-semester sequence for science and engineering students. Covers kinematics, dynamics, momentum of particles and rigid bodies, work and energy, gravitation, simple harmonic motion, fluid statics, and sound waves.
 - b. **Prerequisites or co-requisites:** Knowledge of algebra, geometry and trigonometry. Coreq: APPM 1345 or APPM 1350 or MATH 1300. (minimum grade C-). Credit not granted for this course and PHYS 1115.
 - c. **Indicate whether a required, elective, or selected elective:** Required
6. **Specific goals for the course:**
 - a. **Specific outcomes of instruction:** Students should understand that learning does not mean memorizing answers to specific questions; instead, learning means understanding general strategies, and developing robust internal models which permit one to recognize which strategy is appropriate and how to apply it. In this course, there are two broad strategies that students should master. 1) Newton's Laws. Given appropriate initial conditions of a classical mechanical system, the student should be able to compute the subsequent motion by applying Newton's Laws. This requires mastery of concepts in kinematics and dynamics, and knowing how to apply Newton's Laws in for both translational and rotational motions. 2) Conservation Laws. By comparing a known initial state of a system and a partly-known final state, the student should be able to apply one of the conservation laws (energy, momentum, or angular momentum) to determine the final state of the system.
 - b. **Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.**

7. **Brief list of topics to be covered:** 1D kinematics, Vector Math and 2D motion, Newton's Laws intro, Applications of Newton's Laws, Work, Energy, and Power, Gravity and orbits, Momentum, Center of mass, Rotations, Angular momentum, Static Equilibrium, Simple Harmonics Motion, Fluid Statics, Waves and Sound

PHYS 1120 COURSE SYLLABUS

1. **Course number and name:** PHYS 1120
2. **Credits, contact hours, and categorization of credits in Table 5-1:** 4 credit hours, 4 contact hours, basic science
3. **Instructor's or course coordinator's name:** Two faculty are assigned to this course and the faculty change every semester. In Fall 2022, the instructors were Dr. Daniel Bolton and Prof Ed Kinney. In Spring 23, it is Dr. Michael Dubson and Prof..Ed Kinney
4. **Textbook:** Richard Wolfson, Essential University Physics, Volume 2. (2007). We use the inexpensive eText version which is bundled with the online homework system Mastering Physics. Also, we always use: McDemott et al., Tutorials in Introductory Physics, Prentiss (Pearson), 2002
 - a. other materials: CUClicker, Online PhET simulations at phet.colorado.edu
5. **Specific course information:**
 - a. **Brief description of the content of the course (catalog description):** PHYS 1120 (4). General Physics 2. Three lect., one rec. per week, plus three evening exams in the semester. Second semester of three-semester introductory sequence for science and engineering students. Covers electricity and magnetism, wave motion, and optics. Normally is taken concurrently with PHYS 1140.
 - b. **Prerequisites or co-requisites:** PHYS 1110. Coreqs: MATH 2300 or APPM 1360. Credit not granted for this course and PHYS 1125.
 - c. **Indicate whether a required, elective, or selected elective:** Required
6. **Specific goals for the course:**
 - a. **Specific outcomes of instruction:** Students should understand that learning does not mean memorizing answers to specific questions; instead, learning means understanding general strategies, and developing robust internal models which permit one to recognize which strategy is appropriate and how to apply it. In this course, the general strategy is application of Maxwell's equations. There are two broad categories for applications of Maxwell's equations: 1) Charges, currents, and fields. Given a known distribution of charges and/or currents, students should be able to compute the electric and magnetic fields. Similarly, given the fields, students should be able to compute the forces on and motion of charges. 2) Circuit analysis. Students should be able to understand and analyze simple DC and AC circuits containing batteries, resistors, capacitors, and inductors.
 - b. **Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.**
7. **Brief list of topics to be covered:** Static Electric fields, Gauss's Law, Voltage and capacitance, DC Circuits, Magnetic fields: Biot-Savart Law and Ampere's Law, Faraday's Law, inductance, Electromagnetic waves and Maxwell's equations, Ray Optics

PHYS 1140 Course Syllabus

1. **Course number and name:** PHYS 1140 Experimental Physics 1
2. **Credits, contact hours, and categorization of credits in Table 5-1:** 1 credit hour; 50 minute lecture and 110 minute lab per week
3. **Instructor's or course coordinator's name:** Professor Mihaly Horanyi and Dr. Renee Gurganus (backup coordinator)
4. **Textbook:** No text required
 - a. other materials: CUClicker required
5. **Specific course information:**
 - a. **Brief description of the content of the course (catalog description):** Introduces experimental physics through laboratory observation of a wide range of phenomena. Covers experiments on physical measurements, including mechanics, electricity & magnetism, and optics, with the mathematical analysis of physical errors associated with the experimental process.
 - b. **Prerequisites or co-requisites:** Requires a prerequisite or corequisite course of PHYS 1120 or PHYS 1125 (minimum grade C-).
 - c. **Indicate whether a required, elective, or selected elective:** Required
6. **Specific goals for the course:**
 - a. **Specific outcomes of instruction:** The purpose of the course is for students to learn a few core ideas in experimental physics, including what the distribution of measurement values tells us about the best estimate for the value of the quantity, how to compare measurements using estimated uncertainties in those measurements, and how one can use these ideas to make defendable conclusions about an experiment.
 - b. **Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.**
7. **Brief list of topics to be covered:** Measurement and uncertainties, Systematic vs. random errors, Mechanics, motion, and uncertainties in predictions, Introduction to electronics and signal processing, Introduction to optics and signal transmission

APPENDIX B - FACULTY VITAE

ABET CV for Bernard Amadei

1. **Name:** Dr. Bernard Amadei
2. **Education:**
 - Ph.D. (Civil Eng.), University of California, Berkeley, U.S.A., 1982
 - MaSc (Civil Eng.), University of Toronto, Canada, 1979
 - DEA/MS (Geological Eng.), Natl Polytechnic Institute of Lorraine, France, 1977
 - Dipl. Eng./BS (Geological Eng.), School Appl. Geology & Mining Eng, Nancy, 1977
3. **Academic experience:**
 - 2021-2022 Research professor, University of New Mexico
 - 1994 – 2022 Professor, the University of Colorado at Boulder, CEAE Dept.
 - 2015 – 2018 Co-Director, Mortenson Center in Engineering for Developing Communities, University of Colorado, Boulder
 - 2009 – 2012 Director, Mortenson Center in Engineering for Developing Communities, University of Colorado, Boulder
 - 1989 – 1994 Associate Professor, the University of Colorado at Boulder, CEAE Dept.
 - 1982 – 1989 Assistant Professor, the University of Colorado at Boulder, CEAE Dept.
 - 1979 – 1982 Research Assistant, Ph.D. Thesis: Influence of Rock Anisotropy on Measurement of Stresses In-Situ, University of California, Berkeley
4. **Non-academic experience:**
 - 2021-Present CEO, Common Ground Solutions Center LLC, Lafayette, CO
 - 2013 - 2014 US Science Envoy to Pakistan and Nepal, US Department of State
 - 2002 - Present Founding President, Engineers Without Borders – USA and co-Founder of Engineers Without Borders – International
 - 1982 - Present Independent Consultant in Intl Development, Geological Engineering
 - 1982 Senior Engineer, J. F. T. Agapito and Associates, Inc., Grand Junction, CO
5. **Certifications or professional registrations** N/A
6. **Current membership in professional organizations:**
 - Member, US National Academy of Engineering (2008-present)
 - Member, National Academy of Construction (2013-present)
 - Dist. Member, American Society of Civil Engineers (1982-present)
 - Member, International Society for Rock Mechanics (1984-present)
 - Member, American Society of Mechanical Engineers (2006-present)
 - Member, Institute of Electrical and Electronics Engineers (2011-present)
 - Member, American Society of Engineering Education (2010-present)
7. **Honors and awards:**
 - 2012 Achievement Rewards for College Scientists (ARCS-CO) Honoree of the Year
 - 2013 Member of the National Academy of Construction
 - 2015 Washington Award, The Western Society of Engineers
 - 2015 American Society of Civil Engineers, Outstanding Projects and Leaders

- 2016 C. H. Dunn Award of the Construction Industry Institute
- 2016 Distinguished Professor, University of Colorado
- 2021 Maverick Influencer Award, BuiltWorld
- 2013 Doctor of Engineering (Honoris Causa), Drexel University
- 2014 Doctor of Engineering (Honoris Causa), Worcester Polytechnic Institute
- 2017 Doctor of Science (Honoris Causa), Technion Institute of Technology
- 2019 Doctor of Science (Honoris Causa), SUNY-ESF

8. Service activities (within and outside of the institution):

- Graduate and undergraduate student advising
- Reviewing peer-reviewed publications
- Chair, Advisory Committee on Scientists and Engineers in Exile for Development, US National Academies (2022-)
- Member, US National Academies Roundtable on Science & Technology for Sustainability (2019-)
- US Natl Academy of Engineering, New Voices Advisory Committee (2018-)
- Member (and co-chair), PeaceTech Laboratory Board (2014-)
- Founding President and board member, Engineers Without Borders - USA (2001-)
- Co-Founder of Engineers Without Borders –International Network (2022-)
- Founding Director, Mortenson Center in Eng. for Developing Communities (2008-)

9. Selected Publications & Presentations:

- Amadei, B. (2020). Revisiting positive peace using systems tools. J. of Technology Forecasting and Social Change, 158, <https://doi.org/10.1016/j.techfore.2020.120149>
- Amadei, B. (2020). Agent-based and system dynamics modeling of water field services. Challenges, 11(2), 28; <https://doi.org/10.3390/challe11020013>
- Amadei, B. (2020). A systems approach to community capacity and resilience. Challenges, 11(2), 28; <https://doi.org/10.3390/challe11020028>
- Jordan, R., Amadei, B. et al. (2020) Peace engineering consortium: Outcome of the first global peace engineering conference. Procedia Computer Science, pp. 139-144, <https://doi.org/10.1016/j.procs.2020.05.021>
- Amadei, B. (2021). A systems approach to the sustainability-peace nexus. Sustainability Science. (16)4, pp. 1111-1124. <https://doi.org/10.1007/s11625-020-00902-x>
- Amadei, B. (2021). Systemic Modeling of the Peace–Development Nexus. Sustainability, 13(5), 2522. <https://doi.org/10.3390/su13052522>
- Amadei, B. (2022). An integrated approach to peace and resource security. Int. J. of System Dynamics Applications, IJSDA: 10(4).

10. Briefly list the most recent professional development activities

Writing of three new books to be published in 2023 and 2024

Board members of several NGOs

Development of peace engineering initiative with other universities.

ABET CV for Jeremy Andryauskas

1. **Name:** Jeremy J Andryauskas
2. **Education:**
 - Master, Information Systems, University of Colorado Denver, 2016
 - Master, Engineering, University of Colorado Denver, 2009
 - Bachelor, Environmental Design, University of Minnesota, 2001
3. **Academic experience:**
 - University of Colorado Boulder, Lecturer, 2018-present, part time
 - University of Colorado Denver, Lecturer, 2017-2019, part time
 - Front Range Community College, Adjunct Instructor, 2016-2017, part time
 - ITT Technical Institute, Adjunct Instructor, 2014-2016, part time
4. **Non-academic experience:**
 - Felsburg Holt & Ullevig, Senior Designer, Stormwater designer and drafter, 2022-present, full time
 - Tetra Tech, GIS/CAD Manager, GIS mapping and analysis, Civil Design, 2001-2022, full time
5. **Certifications or professional registrations:**
 - Land Surveyor Intern, 2003
 - Autodesk AutoCAD Civil 3D Certified Professional, 2009
6. **Current membership in professional organizations:** None.
7. **Honors and awards:** None.
8. **Service activities (within and outside of the institution):** None.
9. **Selected Publications & Presentations:** None.
10. **Briefly list the most recent professional development activities**
 - Recent training in Bentley Open Roads Designer.
 - Constant training in Autodesk AutoCAD Civil 3D.

ABET CV for Sid Bhandari

1. **Name:** Siddharth Bhandari

2. **Education:**

PhD in Civil Engineering in 2019, University of Colorado at Boulder

MS in Civil Engineering in 2017, University of Colorado at Boulder

BS in Civil Engineering in 2014, University of Colorado at Boulder

3. **Academic experience:**

2019-present: Associate Director of Research of the Construction Safety Research Alliance, University of Colorado at Boulder

4. **Non-academic experience:** None

5. **Certifications or professional registrations:**

OSHA 10-hour Construction Safety and Health Certification

6. **Current membership in professional organizations**

American Society of Civil Engineers (ASCE)

American Society of Safety Professionals (ASSP)

7. **Honors and awards:**

- Rising Star in Safety Award 2021 from the National Safety Council
- Outstanding Reviewer Award for the journal Practice Periodical on Structural Design and Construction. [2020]
- ELECTRI International's Early Career Award 2019
- Best paper award 2015 5th International/11th Construction Specialty Conference in Vancouver, Canada

8. **Service activities (within and outside of the institution):**

Invited Associated Guest Editor

- Construction Management and Economics Special Issue: What Have we Learnt From COVID-19 Global Pandemic: Improving the Construction Industry's Abilities to Foresee, Respond to, and Recover from Future Endemic Catastrophes. (2021)
Committee Participation (Department, College, or University)
- Member of Term-Limited Professorship Award Review Committee, Western Michigan University (2019-2020).
Conference Sessions Chaired and Technical Committees:
- CIB W099 and TG59 International Conference 2020: Scientific and Technical Committee Member (2021)

Peer-Reviewer (Journals)

- Journal of Management in Engineering (2021 - *present*)
- Journal of Architectural Engineering (2020 – *present*)
- Journal of Safety Research (2020 – *present*)
- Practice Periodical on Structural Design and Construction (2019 – *present*)
- Journal of Construction Economics and Management (2017-*present*)

- Safety Science (2016- present)
- Peer-Reviewer (Conferences)*
- CRC: *Construction Research Congress* Conference (2016 - present).
 - CIB W099 and TG59: *International Safety, Health, and People in Construction* Conference (2015 - present)

9. Selected Publications & Presentations:

- Erkal, E. D. O., Hallowell, M. R., & Bhandari, S. (2023). Formal evaluation of construction safety performance metrics and a case for a balanced approach. *Journal of Safety Research*.
- Bhandari, S., Hallowell, M., Scheve, C., Upton, J., Alruqi, W. M., & Quashne, M. (2022). Assessing the Quality of Safety-Focused Leadership Engagements. *Professional Safety*, 67(01), 22-28.
- Bhandari, S., and Hallowell, M. R. (2022). Influence of safety climate on risk tolerance and risk-taking behavior: A cross-cultural examination. *Safety Science*, 146, 105559.
- Hardison, D., Hallowell, M., Littlejohn, R., Goodrum, P., & Bhandari, S. (2022). The influence of spatial cognition and variability of mental workload among construction hazard prevention through design tasks. *Safety Science*, 152, 105770.
- Alsharef, A., Albert, A., & Bhandari, S. (2022). Safety challenges experienced by driver license examiners and related safety measures. *Safety Science*, 154, 105808.
- Oguz Erkal, E. D., Hallowell, M. R., & Bhandari, S. (2021). Practical Assessment of Potential Predictors of Serious Injuries and Fatalities in Construction. *Journal of Construction Engineering and Management*, 147(10), 04021129.
- Bhandari S., Hallowell, M. R., Alruqi, W., & Salas, R. (2021). “Modeling the Relationship between Personal Risk Tolerance, Work-Related Risk Tolerance, and Risk-Taking Behavior of Construction Workers.” *Journal of Construction Engineering and Management*, 147(4), 04021016.
- Bhandari S., and Hallowell M. R. (2021). “Identifying and Controlling Biases in Expert-Opinion Research: Guidelines for Variations of Delphi, Nominal Group Technique, and Focus Groups.” *Journal of Management in Engineering*, 37(3), 04021015.
- Bhandari, S., and Molenaar, K. R. (2020). “Using Debiasing Strategies to Manage Cognitive Biases in Construction Risk Management: Recommendations for Practice and Future Research.” *Practice Periodical on Structural Design and Construction*, 25(4), 04020033.

- 10. Briefly list the most recent professional development activities:** January 10, 2023:
 Learning from Demonstrations presentation for CSRA members; CSRA Safety Summit;
 CSRA Communities of Practice

ABET CV for Angela Bielefeldt

1. **Name:** Angela R. Bielefeldt

2. **Education:**

Ph.D., Civil & Environmental Engineering, University of Washington, 1996

M.S., Civil & Environmental Engineering, University of Washington, 1994

B.S., Civil Engineering, Iowa State University, 1992

3. **Academic experience:**

Professor, CEAE Dept., University of Colorado Boulder, 2012-present

Director, Engineering Plus / Integrated Design Engineering Program, 2019-present

Faculty Director, Sustainable by Design Residential Academic Program, 2014-2017

Associate Director, Environmental Engineering Program, 2014-2016

Associate Chair for Undergrad Education, CEAE Dept., 2012-13, 2014-15

Associate Professor, CEAE Dept., University of Colorado Boulder, 2003-2012

Director, Environmental Engineering Program, 2006-2010

Assistant Professor, CEAE Dept., University of Colorado Boulder, 1996-2003

University of Canterbury, Christchurch, NZ (sabbatical): Visiting Erskine Fellow,
Dept. Civil and Natural Resources Engineering, 2013

University of Minnesota (sabbatical): Braun Intertec Professorship of Science &
Technology, CEAE Dept. 2005-2006

Iowa State University: Undergraduate Research Assistant, Enviro. Eng, 1987-1992

4. **Non-academic experience:**

Remediation Technologies, Inc., Seattle WA, Assistant Engineer, *EPA SITE project on TCE and DCE gas treatment in packed-bed bioreactors* Summer 1994, FT

Montgomery Watson, Des Moines IA, Assistant Engineer, *Superfund 30% Remedial Design, monitoring and quality assurance plans*, Summer 1992, FT

Sandia National Laboratories, Albuquerque NM, Environmental Engineering Intern, *lab studies and design for in-situ bioremediation of an oil spill site* Summer 1991, FT

CH2M Hill, Reston VA, Environmental Engineering Intern, *calculation checks, bench scale testing for water treatment*, Summer 1990, FT

5. **Certifications or professional registrations:**

Professional Engineer, State of Colorado, #38043, 2003-present

6. **Current membership in professional organizations:**

American Society of Civil Engineers (ASCE)

American Society for Engineering Education (ASEE)

Association of Environmental Engineering & Science Professors (AEESP)

American Association for the Advancement of Science (AAAS)

7. **Honors and awards:**

- ASEE Annual Conference Best Paper from PIC III and the Engineering Leadership Development Division, Komarek, Bielefeldt, and Knight, 2022
- ASCE Journal of Civil Engineering Education Outstanding Associate Editor, 2022

- Woman Who Makes A Difference, Center for Inclusion & Social Change, 2021
- ASEE Annual Conference Best Diversity Paper, Engineering Ethics Division, 2020
- ASEE Annual Conference Best Paper from the Engineering Ethics Division, 2020
- Fellow of the American Society for Engineering Education, 2019
- Univ. of Colorado President's Teaching Scholar (lifetime guild appointment), 2019
- Distinguished Achievement Award, CEAE Dept., Univ. Of Colorado, Boulder, 2019

8. Service activities (within and outside of the institution):

- ASEE: Community Engagement Division, Chair 2018-2020, Past Chair 2020-2023
- Journal Civil Engineering Education, deputy editor, 2020-present
- AAAS Committee on Scientific Freedom & Responsibility, 2017-2023
- Editor International Journal for Service Learning in Engineering, 2020-present
- CU system: Privilege and Tenure Committee, 2018-present
- CU Boulder: VCAC 2023-2026, College of Engineering & Applied Science First Level Review Committee 2017-2020
- Engineering Education AI-Augmented Learning Interdisciplinary Research Theme co-director 2020-2023

9. Selected Publications & Presentations:

- Komarek, R., A. Bielefeldt, D. Knight. 2021. Influences of Engineering Students' College Experiences on Leadership Skill Assurance. *Intl J Engineering Education*. 39 (5), 1454-65.
- Komarek, R., A. Bielefeldt, D. Knight. 2021. Multirater Feedback of Leadership of Underrepresented Groups in a Civil Engineering Capstone Design Course. *Journal of Civil Engineering Education*. 147 (4).
- Harper, J., A. Bielefeldt, A. Javernick-Will, K. Dickinson, T. Veasna, T. Kozole, C. Nicoletti. 2021. Household Preferences for Rural Fecal Sludge Management Services in Cambodia: A Discrete Choice Experiment. *Environmental Science & Technology*.
- Bielefeldt, A., M. Polmear, D. Knight, N. Canney, C. Swan. 2021. Educating engineers to work ethically with global marginalized communities. *Environ Engrg Sci*. 38 (5), 320-30
- Polmear, M., A. Bielefeldt, D. Knight, C. Swan, N. Canney. 2020. Exploratory Investigation of Personal Influences on Educators' Engagement in Engineering Ethics and Societal Impacts Instruction. *Science and Engineering Ethics*. 26 (6).
- Bielefeldt, A., J. Lewis, M. Polmear, D. Knight, N. Canney, C. Swan. 2020. Educating Civil Engineering Students about Ethics and Societal Impacts via Co-curricular Activities. *Journal of Civil Engineering Education*. 146 (4).

10. Briefly list the most recent professional development activities:

ASEE Annual Conference & Exposition, 2022, 2021, 2020, 2019, 2018, 2017

Audited EDUC 8165 Research on Equity Focused Programs in STEM. Prof Taylor Fa2020.

Audited EDUC 8165 SpTpcs: Theories of Math & Science Learning. Prof. Hand. Sp2020.

ABET CV for Shideh Dashti

1. **Name:** Shideh Dashti, Ph.D.

2. **Education:**

Ph.D., University of California at Berkeley, Civil/Geotechnical Engineering, 2009

MS, University of California at Berkeley, Civil/Geotechnical Engineering, 2005

BS, Cornell University, Civil/Environmental Engineering, 2004

3. **Academic Experience:**

Acting Associate Dean for Research, University of Colorado Boulder, 2022-present

Associate Professor, University of Colorado Boulder, 2018-present

Visiting Professor (on sabbatical) at ETH-Zurich, Switzerland, 1/2019-9/2019

Assistant Professor, University of Colorado Boulder, 2011-2018

Postdoctoral Scholar, University of California at Berkeley, Berkeley, CA, 2009-2010

Doctoral Researcher, University of California at Berkeley, Berkeley, CA, 2006-2009

4. **Non-academic experience:**

Geotechnical Engineer, Bechtel National, Inc., San Francisco, CA, 2005-2006

5. **Certifications or professional registrations:** N/A

6. **Current membership in professional organizations:**

American Society of Civil Engineers (American Society of Civil Engineers, ASCE)

Earthquake Engineering Research Institute (EERI)

7. **Awards and Honors:**

- Walter L. Huber Civil Engineering Research Prize, ASCE (2021)
- Assoc Editor of the Yr, *Journal of Geotechnical Engineering & Geomechanics*-2020
- Provost Faculty Achievement Award, CU Boulder (2020)
- American Society Civil Eng Arthur Casagrande Professional Development (2018)
- *Journal of Geotechnical Engineering & Geomechanics* Outstanding Reviewer (2016)
- National Science Foundation CAREER Award (2015)
- Departmental Young Researcher Award, CEAE department, CU Boulder (2015)
- Dean's Faculty Fellowship, College Eng. & Applied Sciences, CU Boulder (2015)
- Departmental Teaching Award, CEAE department, CU Boulder (2014)
- National Science Foundation (NSF) Fellow for ENHANCE (since December 2012)

8. **Service Activities (within and outside of the institution):**

- Undergraduate Research Advising
- Graduate Student Committee participation as primary advisor, committee member
- Post-Doctoral Research Committees, as primary advisor and as committee member
- Assoc. Editor: ASCE Journal of *Geotechnical and GeoEnvironmental Engineering*
- Elected as the board member of the United States Universities Council on Geotechnical Education and Research (USUCGER), <http://www.usucger.org/>.

- Committee member of the *International Society of Soil Mechanics and Geotechnical Engineering* (ISSMGE TC 104), ASCE Geo-Institute.
- ATC Committee on Central and Eastern US Seismic Practice Needs (National Institute of Standards and Technology, NIST)
- International Society of Soil Mechanics and Geotechnical Engineering (ISSMGE TC104 committee member and one of two U.S. representative)
- Earthquake Engineering Soil Dynamics Awards Subcommittee, ASCE Geo-Institute
- National Security Initiatives (NSI) advisory board (2022-current)
- Campus Misconduct Advisory Group, CMAG (2022-current)
- Standing Committee on Research Misconduct, SCRM (2021-current)
- Provost Award Committee (2021-current)
- Journal Article Peer-Reviewer for *Geotechnique*, *Royal Society*, *EERI Journal of Earthquake Spectra*, *Canadian Geotechnical Journal*, *Journal of Earthquake Engineering*, *Geotechnical Testing Journal*, *Soils and Foundations*, *Soil Dynamics and Earthquake Engineering*, *Acta Geotechnica*
- Proposal Reviewer for Swiss National Science Foundation
- NSF's Graduate Research Fellowship Program (GRFP) panel
- NSF's Geotechnical Engineering and Geomechanics unsolicited proposal panel
- NSF's Engineering for Natural Hazards (ENH) unsolicited proposal panel
- US Geological Survey (USGS) Earthquake Engineering (EE) panel

9. Selected Publications & Presentations:

- Anderson, D.J., Franke, K.W., Kayen, R.E., Dashti, S., Badanagki, M. (2022). "The over-prediction of seismically induced liquefaction during the 2016 Kumamoto, Japan earthquake sequence," *Geosciences* 13(7), <https://doi.org/10.3390/geosciences13010007>.
- Pinto, F., Ledezma, C., Abell, J., Dashti, S., Astroza, R. (2022). "Soil-Basement Interaction Effects on the Seismic Response of Tall Buildings with Basement Levels," *Engineering Structures*, 263, 114406. <https://doi.org/10.1016/j.engstruct.2022.114406>.
- Bullock, Z., Liel, A.B., Porter, K., Dashti, S. (2021). "Site-Specific Liquefaction Fragility Analysis: Cloud, Stripe, and Incremental Approaches," *J. of Earthquake Eng. and Structural Dynamics*, Issue 9, DOI: <https://doi.org/10.1002/eqe.3458>.
- Fischer, E., Wham, B., Dashti, S., Javernick-Will, A., Liel, A., Whelton, A., Berty, N., Klingaman, J., Metz, A., Ramos, J., Rose, H.R. (2022). "2021 Marshall Wildfire," Geotechnical Extreme Event Reconnaissance (GEER) Report.doi:10.18118/G6KT04.

10. Briefly list the most recent professional development activities:

CU Boulder Today articles on Turkey Earthquake and "Pioneering Resilient Infrastructure" Organization of the "Women in Engineering" event 3/8/23

ABET CV for Michael Gooseff

1. Name: Michael N Gooseff

2. Education:

- Ph.D. Civil Engineering, University of Colorado, Boulder, CO, 2001
- M.S. Civil Engineering, University of Colorado, Boulder, CO, 1998
- B.C.E. Civil Engineering, Georgia Institute of Technology, Atlanta, GA, 1996

3. Academic Experience:

- 2018-current Professor, CEAE department, and Fellow of the Institute of Arctic & Alpine Research (INSTAAR), University of Colorado, FT
- 2015-2018 Associate Professor, CEAE department, University of Colorado, FT
- 2013-2015 Associate Professor, Civil & Environmental Engineering, Colorado State University, FT
- 2011-2013 Associate Professor, Civil & Environmental Engineering, Pennsylvania State University, FT
- 2007-2011 Assistant Professor, Civil & Environmental Engineering, Pennsylvania State University, FT
- 2004-2007 Assistant Professor, Geology & Geological Engineering, Colorado School of Mines, FT
- 2002-04 Asst Professor, Aquatic, Watershed & Earth Resources, Utah State Univ, FT
- 2001-02 Postdoctoral Researcher, Department of Geosciences, Oregon State Univ, FT

4. Non-Academic Experience:

- 1996-98 Assistant Environmental Planner, Hydrosphere Resource Consultants, Boulder, CO
- 1994 Assistant Project Engineer, GEDCO Group, Inc., Smyrna, GA

5. Certifications or professional registrations:

- Engineer In Training Certification #18279, State of GA, 1996

6. Membership in Professional Organizations:

- American Geophysical Union
- Geological Society of America
- US Permafrost Association

7. Honors and Awards:

- Robert L. Stearns Award, CU Boulder Alumni Association, 2022
- *Research Development Award*, CEAE dept., University of Colorado, Boulder, 2019
- *Fellow*, Geological Society of America, 2017
- Outstanding Teaching Award 2011 (Pennsylvania State Engineering Alumni Society)
- Harry West Teaching Award, 2011-2012 (Department of Civil & Environmental Engineering, Pennsylvania State University)

8. Service Activities (within and outside of the institution):

- Member, *Polar Research Board* of the National Academy of Sciences (2017-2022)

- Co-Chair, Environmental Systems Science Working Group, BERAC International Benchmarking Analysis, Department of Energy
- Commissioner and Chair, *Water Quality Control Commission*, State of Colorado (2017-2022, chair from 2021-2022)
- Co-Director of the CU Hydrologic Sciences Graduate Program
- Civil, Environmental, & Architectural Engineering Dept. Executive Committee (3 year term)
- Chair of Civil, Environmental, & Architectural Engineering Dept JEDI Committee (2021-2022)
- Chair of INSTAAR Personnel Committee (2021-2022)

9. Selected Publications & Presentations:

** - graduate advisee; * - graduate student

- Hudson, AR, DPC Peters, JM Blair, DL Childers, PT Doran, K Geil, **M Gooseff**, KL Gross, NM Haddad, MA Pastore, JA Rudgers, O Sala, EW Seabloom, and G Shaver. 2022. Cross-site comparisons of dryland ecosystem response to climate change in the US Long-Term Ecological Research network. *BioScience*, 72(9): 889-907
- Salvatore, MR, JE Barrett, RB Schuyler, SN Power, LF Stanish, ER Sokol and **MN Gooseff**. 2021. Counting carbon: Quantifying biomass in the McMurdo Dry Valleys through orbital & field observations. *International Journal of Remote Sensing*, 42:22, 8597-8623, doi: 10.1080/01431161.2021.1981559.
- **Bergstrom, A, **M Gooseff**, A Fountain, and M Hoffman. 2021. Long-term shifts in feedbacks among glacier surface change, melt generation, and runoff, McMurdo Dry Valleys, Antarctica. *Hydrological Processes*, 35(8): e14292; doi:10.1002/hyp.14292.
- **Singley, JG, **MN Gooseff**, DM McKnight, and ES Hinckley. 2021. The role of hyporheic connectivity in determining nitrogen availability: Insights from an intermittent Antarctic stream. *Journal of Geophysical Research: Biogeosciences*, 126
- **Conner, A, **MN Gooseff**, X Chen, E Arntzen, and V Garayburu-Caruso. 2021. Groundwater inflows to the Columbia River along the Hanford Reach and associated nitrate loading. *Frontiers in Water*, doi: 10.3389/frwa.2021.574684.
- Hensley, RT, **MJ Spangler, *LF DeVito, PH Decker, MJ Cohen, and **MN Gooseff**. 2020. Evaluating spatiotemporal variation in water chemistry of the upper Colorado River using longitudinal profiling. *Hydrological Processes*, 34(8):1782-1793.
- Terry, N, E Grunewald, M Briggs, **M Gooseff**, AD Huryn, MA Kass, KD Tape, **P Hendrickson, and JW Lane Jr. 2020. Seasonal subsurface thaw dynamics of an aufeis feature inferred from geophysical methods. *Journal of Geophysical Research – Earth Surface*, 125(3): doi:10.1029/2019JF005345.
- Post, E, RB Alley, TR Christensen, M Macias-Fauria, BC Forbes, **MN Gooseff**, A Iler, JT Kerby, KL Laidre, ME Mann, J Olofsson, JC Stroeve, F Ulmer, RA Virginia, and M Wang. 2019. The polar regions in a 2 degrees C warmer world. *Science Advances*, 5(12): ARTN eaaw9883.

10. Briefly list the most recent professional development activities:

I regularly attend and present at national and international scientific conferences.

ABET CV for Alex Gore

1. Name: Alex Gore

2. Education:

North Dakota State University, Fargo, ND
Master of Construction Management May 2011
Master of Architecture - May 2008
B.S. of Environmental Design - May 2007

3. Academic experience:

University of Colorado Boulder, Lecturer, Part Time, 2013-2023
Architectural Engineering Drawing-AREN 1027 | CEAE Department
Advanced Design Lab 1 - ENVD 4100 | Environmental Design Department
Computational Methods - ENVD 4352 | Environmental Design Department

4. Non-academic experience:

Owner/Co-Founder |F9 Productions Inc., Longmont, CO (02/10 - Present)
Currently responsible for obtaining and managing multiple commercial and residential architecture and construction projects by means of recurring clientele and new solicitations for business.

Owner/Co-Founder |F14 Productions Inc., Longmont, CO Construction Company (11/18 - Present). With 20+ years of construction experience, and a Class B General Contractor's license this experience allows me to provide clients with construction incite from the inception of the project in order to create a more on-budget, on-time solution that meets their programmatic and aesthetic goals.

Junior Architect|Studio Daniel Libeskind (10/08-07/09)

- Helped develop the masterplan and landmark tower for the Yongsan Development project in Seoul Korea.
- Modeler, highrise designer, and conducted daily meetings with Daniel Libeskind while in office
- Researched sustainable methods for Maya Island project in Abu Dhabi
- Coordinated presentation graphics, planning concepts, and schematic layouts for all projects

Independent Architectural Consultant | Fargo, ND (04/06-09/07)

- Spearheaded masterplan and development coordination for Underwood, ND
- Developed architectural identity of \$88 million Educational Campus Center in Minneapolis, MN.

Community Planner | Ulteig Engineers, Fargo, ND (01/07-05/07)

- Researched city economics and city development
- Strategized South Dakota's capital future development: Pierre, SD
- Reorganized strip-mall planning into walkable city extension for Sabin, MN

Army National Guard | Fargo, ND (09/01-09/10)

- Obtained Corporal Rank
- Basic Training Top Graduate
- Advanced Individual Training Top Graduate
- Heavy Equipment Operator
- Construction work on Alaskan highway, CMU facility in Germany, and flood protection dikes in Fargo, North Dakota

5. Certifications or professional registrations:

Registered Architect

6. Current membership in professional organizations:

National Council of Architectural Registration Boards

7. Honors and awards:

- Horizon Award Winner: The Horizon Award recognizes alumni who have graduated within the past 15 years and have attained great success in their profession or have been engaged in outstanding community service.
- 1st Place|Architizer A+ Award|Architecture+Living Small 2016
- 1st Place|Dreamhub Competition|Team Studio Daniel Libeskind 2008
- 1st Place|Alpha Rho Chi|Awarded to the student who best exemplifies leadership, service, & professional merit 2008
- 1st Place|NDSU sustainable skyscraper competition 2007
- 1st Place NDSU Concrete Inc. 2006
- ASLA Merit Award|Underwood, ND 2007
- Notable Entry Award|Re:Connect competition for visionary thinkers 2007

8. Service activities (within and outside of the institution):

- Volunteer architecture services for local Parks and Recreation Department

9. Selected Publications & Presentations:

- Mercury 100 - 3rd Fastest Growing Private Companies in the Boulder Valley Tier V |2017
- Mercury 100 - 6th Fastest Growing Private Companies in the Boulder Valley Tier IV |2018
- Mercury 100 - Fastest Growing Private Company in the Boulder Valley Tier III |2020
- Cover of Builder Magazine | Jan. 2021 - Colorado custom home embodies efficiency, longevity, and functionality.
- Modern in Denver Magazine|Spring 2018 – Master of Disaster
- HGTV |Tiny House Big Living Season 1 Episode 13 - Alex and Lance's Amazing Unfoldable Tiny House

10. Briefly list the most recent professional development activities:

Co-Host of Inside the Firm Podcast – Topics: Architecture/Construction

ABET CV for Gregor Henze

1. **Name:** Gregor P. Henze, Ph.D., P.E.

2. **Education:**

Technical University of Berlin, Germany, Mechanical Engineering, B.S.	1989
Oregon State University, Mechanical Engineering, M.S.	1991
Technical University of Berlin, Germany, Mechanical Engineering, Dipl.-Ing.	1992
University of Colorado Boulder, Civil Engineering, Ph.D.	1995

3. **Academic Experience:**

University of Colorado Boulder, Professor, 2008 - today, FT
Universidad de Sevilla, Andalusia, Spain, Visiting Professor, 2014 – 2015, FT
University of Nebraska-Lincoln, Assistant and Associate Professor, 1999 - 2008, FT

4. **Non-Academic Experience:**

National Renewable Energy Laboratory, Golden, Co., 2013-today, Joint Professor,
PT CSIRO Energy Centre, Newcastle, Australia, Jan.-June 2022, Visiting Scientist,
FT
Eurac Research Institute for Renewable Energy, Jul-Dec. 2021, Visiting Scientist, FT
Fraunhofer Solar Energy Systems, Germany, Oct 2005-July 06, Visiting Scientist, FT
Johnson Controls, Essen, Germany, Jan. 1996-Aug. 1999, Engineering Manager, FT

5. **Certifications or Professional Registrations:**

ASHRAE-certified High-Performance Building Design Professional
Licensed professional mechanical engineer in Nebraska

6. **Current Membership in Professional Organizations:**

ASHRAE, International Building Performance Simulation Association USA

7. **Honors and Awards:**

- Fulbright Distinguished Chair in Science, Technology, and Innovation at CSIRO in Newcastle, New South Wales, Australia 2022
- Interim Co-Director Renewable and Sustainable Energy Institute 2020-2021
- RASEI Associate Director for Energy Systems for the Built Environment 2017
- Charles Victor Schelke Endowed Chair 2017
- University of Colorado Architectural Engineering Appreciation Award 2015
- University of Colorado CEAE Department Distinguished Achievement Award 2012
- Colorado Cleantech Industry Association Research & Commercialization Award 2011
- University of Colorado CEAE Department Research Development Award 2011
- Best Paper Awards, ASME International Solar Energy Conferences 1996, 2002, 2004
- Full Fulbright Scholarship for graduate study at Oregon State University 1990-1991

8. **Service Activities (within and outside of the institution):**

- Chair-Workshop on Intelligent Building Operations, Univ. of Colorado, Aug 2019
- Co-Chair-Workshop on Intelligent Building Operations, Purdue Univ., June 2018
- Associate Editor for IEEE Control Systems Letters 2017 – 2020

- Co-Chair-Workshop on Intelligent Building Operations, Purdue Univ., June 2016
- Editorial Board Member for Journal Building Performance Simulation since 2015
- Associate Editor for ASCE Journal of Architectural Engineering 2015 – 2019
- Associate Editor of Elsevier Journal *Renewable Energy* for 2014 – 2015.
- Renewable and Sustainable Energy Institute (RASEI) Associate Director, 2017-2021
- Chair for Workshop on Intelligent Building Operations, Boulder, June 2013
- Chair for Workshop on Model Predictive Control in Buildings, Montreal, June 2011.
- American Society of Mechanical Engineers Solar Energy Division Technical Committee Chair for Conservation and Solar Buildings for 2008-2014.
- Associate Editor of the *Journal of Solar Energy Engineering* in the topical area of “Conservation and Solar Buildings” for 2008-2014.
- Member of ASHRAE committee charged with developing a certification program on Sustainable Building Design and Operation
- ASHRAE: Technical Committee 7.5 Smart Building Systems, 1.4 Control Theory

9. Selected Publications & Presentations:

- Allen, A., Henze, G., Baker, K., Pavlak, G., & Murphy, M. (2022). An optimization framework for the network design of advanced district thermal energy systems. *Energy Conversion and Management*, 266, 115839.
- Marzullo, T., Dey, S., Long, N., Leiva Vilaplana, J., & Henze, G. (2022). A high-fidelity building performance simulation test bed for the development and evaluation of advanced controls. *Journal of Building Performance Simulation*, 15(3), 379-397.
- Tan, S. Y., Jacoby, M., Saha, H., Florita, A., Henze, G., & Sarkar, S. (2022). Multimodal sensor fusion framework for residential building occupancy detection. *Energy and Buildings*, 258, 111828.
- Jacoby, M., Tan, S. Y., Katanbaf, M., Saffari, A., Saha, H., Kapetanovic, Z., Garland, J., Florita, A., Henze, G., Sarkar, S. & Smith, J. (2021). WHISPER: Wireless Home Identification and Sensing Platform for Energy Reduction. *J Sensor and Actuator Networks*, 10(4), 71.
- Cruickshank, R., Henze, G., Florita, A., Corbin, C., & Stone, K. (2022). Estimating the value of jointly optimized electric power generation and end use: a study of ISO-scale load shaping applied to the residential building stock. *J Build Perf Simulation*, 15(4), 507-535.
- Jacoby, M., Tan, S. Y., Henze, G., & Sarkar, S. (2021). A high-fidelity residential building occupancy detection dataset. *Scientific Data*, 8(1), 1-14.
- Mosiman, C., Henze, G., & Els, H. (2021). Development and Application of Schema Based Occupant-Centric Building Performance Metrics. *Energies*, 14(12), 3513.
- Fleschutz, M., Bohlayer, M., Braun, M., Henze, G., & Murphy, M. D. (2021). The effect of price-based demand response on carbon emissions in European electricity markets: The importance of adequate carbon prices. *Applied Energy*, 295, 117040.

10. Briefly list the most recent professional development activities:

Time Series Analysis with a Focus on Modeling and Forecasting in Energy Systems, Danish Technological University, Copenhagen, Denmark, August 15-19, 2022.

ABET CV for Yu-Hsuan Lee

1. **Name:** Yu-Hsuan Lee
2. **Education:** Ph.D., Civil Engineering, University of Colorado Boulder, 2017-Present
3. **Academic experience:**
 - University of Colorado Boulder, Instructor, 2021-2022, part-time
 - University of Colorado Boulder, Teaching Assistant, 2017-2020, part-time
4. **Non-Academic experience:**
 - Los Alamos National Laboratory, Intern, 2019, 2021, 2022, part-time
5. **Certifications or professional registrations:** N/A
6. **Current membership in professional organizations:** N/A
7. **Honors and awards:** N/A
8. **Service activities (within and outside of the institution):** N/A
9. **Selected Publications & Presentations:**
 - DEM Study of Two Types of Direct Simple Shear and Stress Tensor Computation, Beichuan Yan, Zhou Lei, Richard Regueiro, Engineering Mechanics Institute Conference 2022
10. **Briefly list the most recent professional development activities:**
 - Engineering Mechanics Institute Conference 2022
 - Research of DEM simulations and constitutive analysis of hyper-velocity penetration

ABET CV for Christian Ley

1. Name: Christian Ley

2. Education:

Ph.D., Environmental & Ecological Engineering, Purdue University, 2021

M.S., Environmental & Ecological Engineering, Purdue University, 2019

B.S. Biosystems Engineering, Oklahoma State University, 2017

3. Academic Experience:

University of Colorado: Lecturer	1/2023 – 5/2023
University of Colorado: ASEE Postdoctoral Fellow	9/2021 – Present
Purdue University: NSF Graduate Research Fellow	8/2017 – 8/2021
Oklahoma State University: Undergraduate Research Fellow	8/2013 – 5/2017
NSF Research Experience for Undergraduates	5/2014 – 7/2014

4. Non-Academic Experience:

USDA Agricultural Research Service, Plant pathology research asst. 8/2013 – 5/2014

5. Certifications or Professional Registrations: Engineer in training, Registered in Col

6. Current membership in professional organizations:

American Society for Engineering Education

Association of Environmental Engineering and Scientific Professors

7. Honors and awards:

- ASEE Engineering Postdoctoral Fellowship 2021
- Purdue University: *College of Eng. Outstanding Graduate Research Award* 2021
- NSF Graduate Research Fellowship 2017
- ASABE Yoerger Preprofessional Engineer of the Year 2017
- Honors College: *Honors College Degree Recipient* 2017
- CASNR Dean's Award of Excellence and Outstanding Senior Award 2017
- EPSCOR Research Day at the Capitol: *Grand Prize Winner* 2016
- ASABE K.K. Barnes Essay Competition: *2nd Place* 2016
- Udall National Scholarship: *Institutional Nominee* 2015

- OSPE Undergraduate Research Symposium Poster Contest: *2nd Place 2015*
- Henry Bellmon Scholar Development Essay Competition: *1st Place Dec 2014*

8. **Service activities (within and outside of the institution):**

- *Water Supply in Developing Countries, Purdue University 2018 - 2021*
- *International Preprofessional Community of ASABE 2016 – 2017*
- *American Society of Agricultural and Biological Engineers & Dept. Service 2013-17*

9. **Selected Publications & Presentations:**

- Ben Ma, Y. Linden, P.M. Gundy, S. Seyedi, **Christian J. Ley**, L. Ikner, K. Bright, Chuck Gerba, M.D. Sobsey, P. Piper, and Karl G. Linden. (2022). UV inactivation of common pathogens and surrogates under 222 nm irradiation from KrCl* excimer. *Photochemistry & Photobiology*.
- TG Aw, L. Scott, K. Jordan, K. Ra, **Christian Ley**, Andrew J. Whelton. (2022) Prevalence of Opportunistic Pathogens in a School Building Plumbing during Periods of Low Water Use and a Transition to Normal Use. *Int. Journal of Hygiene and Environ. Health*
- ES Montagnino, CR Proctor, K. Ra, **Christian J. Ley**, Y. Noh, K. Vigil, TG Aw, S Dasika, Andrew J. Whelton. (2022) Over the weekend: Water stagnation and contaminant exceedances in a green office building. *PLOS One Water*.
- JK. Hawes, L. Haugen-Payne, R. Johnson, **Christian J. Ley**, C. Grady, Ernest Blatchley. (2021) Global Service-Learning - A systematic review of principle and practice. *International Journal of Research on Service-Learning and Community Engagement*.
- Tolulope Odimayomi, Caitlin R. Proctor, Q Erica Wang, A Sabbaghi, KS Peterson, D Yu, J Lee, Amisha D Shah, **Christian J. Ley**, Yoorae Noh, Andrew J Whelton. *Et al.* (2021) Water Safety Attitudes, Risk Perception, Experiences, and Education for Households Impacted by the 2018 Camp Fire, California. *Journal of Natural Hazards*.
- **Christian J. Ley**, C.R. Proctor, K. Jordan, K. Ra, T. Odimayomi, Y. Noh, R. Julien, A.J. Whelton, and T.G. Aw. (2020) Impacts of Municipal Water–Rainwater Source Transitions on Microbial and Chemical Water Quality Dynamics at the Tap. *Env. Science and Technology*.
- **Christian J. Ley**, Caitlin R. Proctor, Gulshan Singh, Kyungyeon Ra., Tolulope Odimayomi, Yoorae Noh, Maryam Salehi, Ryan Julien, Jade Mitchell, A. Pouyan Nejadhashemi, Andrew J. Whelton, and Tiong G. Aw. (2020) Drinking water microbiology in a water-efficient building: Stagnation, seasonality, and physiochemical effects on opportunistic pathogen and total bacteria proliferation. *Environmental Science: Water Research & Technology*

10. **Briefly list the most recent professional development activities:**

- *ASEE eFellows Webinar: Establishing Your First Classroom* with Kaitlin Mallouk, June 2023
- *ASEE eFellows Webinar: Navigating Institutional Culture*, Adrienne Minerick, March 2023
- *Writing Your Teaching Statement for the Academic Job Market*, CU Boulder, Dec. 2022

- *Building Community with Active Learning*, CU Boulder, Nov. 2022
- *Making A Course Your Own: Personalizing Course Design*, CU Boulder, Nov. 2022

ABET CV for Sheldon Masters

1. Name: Sheldon V. Masters

2. Education:

Ph.D. Civil Engineering, Virginia Tech, Blacksburg, VA, 2015

M.S. Civil Engineering, Virginia Tech, Blacksburg, VA, 2011

B.A. Mathematics, The College of Wooster, Wooster, OH, 2009

3. Academic Experience:

Assistant Professor, CEAE Department, University of Colorado Boulder 2021-present

Affiliated Professor, Materials Science & Engineering Program, University of Colorado Boulder 2022-Present

Visiting Research Professor, CEAE dept, Drexel University, Aug 2017-July 2021

Research Assistant, Virginia Tech University, Jan 2010-May 2015

4. Non-Academic Experience:

Sr. Environmental Engineer, Corona Environmental Consulting, Aug 2015-July 2021

Research Engineer, Environmental Science, Policy, and Research Institute, February 2016-July 2021

5. Certifications or Professional Registrations:

Future Professoriate Graduate Certificate

6. Current membership in professional organizations:

Professional Memberships in *Association of Environmental Engineering and Science Professors*, *American Society of Civil Engineers*, *American Water Works Association*, *National Society of Black Engineers*

7. Honors and awards:

- 2021 *Environmental Science & Technology* Best Paper Award, Policy Analysis, First Runner-up, **Masters, S.V.**, Bradley, T.C., Burlingame, G.A., Seidel, C.J., Schmelling, M. and Bartrand, T.A. (2021). What Can Utilities Expect from New Lead Fifth-Liter Sampling Based on Historic First-Draw Data? 55(17), 11491-11500.
- Paper selected as an American Chemical Society Editors' Choice for scientific research of broad public interest: Using the Lead and Copper Rule Revisions Five-Sample Approach to Identify Schools with Increased Lead in Drinking Risks (2022). *Environmental Science & Technology Letters*, 9(1), 84-89
- Paper recognized as one of the journal's "High-Impact Articles" between 2015 and 2017: Increased lead in water associated with iron corrosion (2015). *Environmental Engineering Science*, 32(5), 361-369
- *The Inaugural Ut Prosim Scholar Award*, Virginia Tech, 2016, for the application of engaged science in protecting the people of Flint, MI
- *Alumni Award for Outreach Excellence*, Virginia Tech, 2016, in recognition of the Flint Water Study Team for bringing national attention and providing outreach assistance for the Flint, MI water crisis

- *Proclamation from the City Council of the City of West Hollywood*, 2016, in recognition of the Virginia Tech team for its outstanding dedication to representing the public interest, protecting the welfare of Flint residents, and preserving ethical standards in the sciences
 - *Association of Environmental Engineering and Science Professors (AEESP) Presentation Award*, Yale University, 2015
 - *Graduate Student of the Year*, Virginia Tech, 2015
8. **Service activities (within and outside of the institution):**
- Peer Reviewer for 4 journal articles
 - EVEN Program Seminar organizer
9. **Selected Publications & Presentations:**
- McCuin, R., **Masters, S.**, Bartrand, T., Clancy, J. (2022). Impact of Pipe Material, Operation and Disinfectant on Cold Water Plumbing Microbiology. *AWWA Water Science*, e1306.
 - **Masters, S.V.**, Poncelet-Johnson, N., Walsh, R., Seidel, C.J., Corwin, C.J. (2022). Comparison of Coupon and Pipe Rack Studies for Selecting Corrosion Control Treatment. *AWWA Water Science*, e1293.
 - McNamara, R., Estes-Smargiassi, S., **Masters, S.V.**, Roberson, A., Beighley, R.E., Pieper, K.J. (2022). Using the Lead and Copper Rule Revisions 5-sample approach to identify schools with increased lead in drinking water risks. *Environmental Science & Technology Letters*, 9(1), 84-89
10. **Briefly list the most recent professional development activities:**
National Center for Faculty Development & Diversity Faculty Success Program.

ABET CV for Matthew Morris

1. **Name:** Matt Morris
2. **Education:** B.S. Civil Engineering (CU Boulder 1999)
M.S. Civil Engineering (CU Boulder 2022)
3. **Academic experience:**
CU Boulder Teaching Professor / Sr. Instructor (2012-2023)
4. **Non-academic experience:**
U.S. Air Force, Captain, civil engineer officer (1999-2006)
Mortenson Construction, Project Manager, (2006-2012)
5. **Certifications or professional registrations:**
Professional Engineer, Colorado
6. **Current membership in professional organizations:** N/A
7. **Honors and awards:**
 - 2022 Civil Engineering Faculty Appreciation Award
 - 2021 Civil Engineering Faculty Appreciation Award
 - 2020 College of Engineering and Applied Science Charles A. Hutchinson Memorial Teaching Award
 - 2020 Civil Engineering Faculty Appreciation Award
 - 2019 College of Engineering and Applied Science Max S. Peters Faculty Service Award
 - 2019 Civil Engineering Faculty Appreciation Award
 - 2018 Top 20 Teaching Performers, College of Engineering and Applied Science
 - 2018 Civil Engineering Faculty Appreciation Award
 - 2018 Architectural Engineering Faculty Appreciation Award
 - 2017 Teaching Award, CEAE Department
 - 2016 Service Award, CEAE Department
 - 2016 Civil Engineering Faculty Appreciation Award
 - 2014 Architectural Engineering Faculty Appreciation Award
 - 2013 Marinus Smith Award, University of Colorado
8. **Service activities (within and outside of the institution):**
 - Enrichment Program Director
 - Student Pathways Committee
9. **Selected Publications & Presentations:** N/A – teaching faculty
10. **Briefly list the most recent professional development activities:**
Organization of Construction Diversity Summit
Discussion of Marshall Fire experience and rebuilding, “Concrete Credentials” podcast

ABET CV for Roseanna Neupauer

1. Name: Roseanna M. Neupauer

2. Education:

Ph.D., Hydrology, New Mexico Institute of Mining and Technology, 2000
M.S., Mathematics, New Mexico Institute of Mining and Technology, 1999
S.M., Civil Engineering, Massachusetts Institute of Technology, 1991
B.S., Civil Engineering, Carnegie Mellon University, 1989
B.A., Spanish Language and Literature, University of Colorado Boulder, 2018

3. Academic experience:

University of Colorado Boulder, full-time
Professor (2016 – present)
Associate Professor (2009 – 2016)
Assistant Professor (2005 – 2009)
University of Virginia – Assistant Professor (2001 – 2004), full-time

4. Non-academic experience:

Idaho National Engineering Laboratory
Senior Engineer (1992 – 1995)
Engineer (1991 – 1992)
Subsurface and Environmental Modeling Group – groundwater flow and transport modeling of Snake River Plain aquifer and other sites; Environmental Engineering Group – environmental support of radioactive waste treatment

5. Certifications or professional registrations:

Professional Engineer, State of New Mexico, #13877, February 1998
Professional Engineer, Commonwealth of Virginia, #0402037137, April 2002

6. Current membership in professional organizations:

American Geophysical Union
American Society for Engineering Education
American Society of Civil Engineers (EWRI Fellow since 2022)
Geological Society of America (Fellow since 2010)
International Association of Hydrological Sciences
National Ground Water Association, Society for Industrial and Applied Mathematics

7. Honors and awards (Lifelong and Recent awards only)

- Margaret S. Petersen Award, Environmental and Water Resources Institute of the American Society of Civil Engineers, 2022
- Fellow, Environmental and Water Resources Institute of the American Society of Civil Engineers, since 2022
- Max S. Peters Faculty Service Award, College of Engineering and Applied Science, University of Colorado Boulder, 2021
- 2019 Editors' Citation for Excellence in Refereeing for Water Resources Research
- "Best Should Teach" Faculty Gold Award, University of Colorado Boulder, 2016

- Fulbright U.S. Scholar Grant, 2015
- President's Teaching Scholar, University of Colorado, since 2015
- Fellow, Geological Society of America, since 2010

8. Service activities (within and outside of the institution):

External

- Associate Editor, *Journal of Hydrologic Engineering*, 2019 – present
- Vice President, International Commission on Groundwater of the International Association of Hydrological Sciences, 2019 – present
- Chair, Groundwater Management Committee, American Society of Civil Engineers (ASCE), 2022 – present
- Member, Groundwater Hydrology Committee, ASCEs, 2014 – present
- Member, Groundwater Symposium Committee, ASCE, 2007 – present

Internal

- Member, Hydrologic Sciences Faculty Steering Committee, 2014 - present
- University Representative, Consortium of Universities for the Advancement of Hydrologic Science, Inc., 2014 – present
- Member, CEAE Curriculum Committee, 2010 - present
- Member, CEAE Undergraduate Student Pathways Committee, 2020 - present
- Faculty Advisor, Chi Epsilon, 2020 - present

9. Selected Publications & Presentations:

- Neupauer, R.M., Civil Engineering Education as an Engineering Process: Personal Perspectives From Over Two Decades in the Classroom, Margaret S. Petersen Award Presentation, World Environmental and Water Resources Congress, Atlanta, Georgia, June 7, 2022. This presentation was an honorary presentation for receiving the Margaret S. Petersen Award.
- Okkonen, J., R. Neupauer, E. Kozlovskaya, N. Afonin, K. Moisio, K. Taewook, and E. Muurinen, Frost quakes: crack formation by thermal stress, *Journal of Geophysical Research: Earth Surface*, 125, e2020JF00516, doi:10.1029/2020JF00516, 2020.
 - This work was featured in EOS: Pinson, J. (2020), Predicting the Next Big Frost Quake, Eos, 101, <https://doi.org/10.1029/2020EO151183>.
 - Based on this work, I was interviewed by Accuweather: “Weather likely behind large booms heard in Wisconsin”, Accuweather Network, <https://www.accuweather.com/en/videos/weather-likely-behind-large-booms-heard-in-wisconsin/w1smJIZW>, Aired December 29, 2020.
- Neupauer, R.M., E.J. Roth, J.P. Crimaldi, D.C. Mays, and L.J. Sather, Demonstration of reversible dispersion in a Darcy-scale push-pull laboratory experiment, *Transport in Porous Media*, DOI : 10.1007/s11242-021-01682-3, 2021. This work demonstrated a rare phenomenon of reversible dispersion and introduced a mathematical modeling approach to simulate it.

10. Briefly list the most recent professional development activities:

Attended short course on Modflow-6, 2019

Audited course on The Arctic Environment, 2022

ABET CV for Fatemeh Pourahmadian

1. **Name:** Fatemeh Pourahmadian

2. **Education:**

Ph.D., Civil Engineering/Geomechanics, University of Minnesota, Twin Cities, 2016

M.S., Geo-Engineering, University of Minnesota, Twin Cities, 2015

M.S., Mechanical Engineering, Iran Univ. of Science and Technology, Tehran, 2010

3. **Academic Experience:**

CEAE Dept., University of Colorado Boulder 2017–present, Assistant Professor

Applied Mathematics Dept, Univ Colorado Boulder, 2019–present, Affiliated Faculty

Department of Civil, Environmental & Geo-Engineering, University of Minnesota,

Twin Cities, 2016–2017 Postdoctoral Research Associate; 2011–2016 Research Asst.

Dept. of Mechanical Engineering, Iran University of Science and Technology, Tehran

2010–2011 Research Associate; 2008–2010 Research Assistant

4. **Non-academic experience:** N/A

5. **Certifications or professional registrations:** N/A

6. **Current membership in professional organizations:**

Society of Engineering Science (SES)

Society for Industrial and Applied Mathematics (SIAM)

American Mathematical Society (AMS)

Engineering Mechanics Institute (EMI)

American Society of Mechanical Engineers (ASME)

7. **Honors and Awards:**

• Sommerfeld Fellowship (2011-12) Civil, Environmental & Geo-Eng Dept, Univ of MN

• Daneshy Fellowship (2014, 2015) Civil, Environmental & Geo-Eng Dept, Univ of MN

8. **Service activities (within and outside of the institution):**

- Vice Chair of the *Elasticity Committee* in the Engineering Mechanics Institute (EMI)
- Member of the *EMI Machine Learning In Mechanics Committee*
- Member of the *EMI Dynamics Committee, EMI Properties of Materials Committee*
- Co-organizer *Data-driven Engineering Science Seminars* Univ of Colorado Boulder
- Coordinator of the *CEAE Engineering Science Program*, Univ. of Colorado Boulder
- Member CEAE Department Undergraduate Pathways Committee, R&A Committee
- Mentor in the NSF S-STEM Program, advising multiple students
- Graduate student advisor, thesis committee member for multiple graduate students
- Undergraduate and Post-doctoral research supervisor
- Reviewer for NSF ECI, Innovative Seed Grant, AB Nexus, UROP Grant
- Co-chair of mini-symposium on:
 - digital twins, *45th Annual Review of Progress in Quantitative Nondestructive Evaluation*, Burlington, VT, July 2018 (with Steve Holland, Iowa State University)

- novel methods in imaging and multiscale characterization of damage in complex materials, *Engineering Mechanics Institute Conference*, Caltech, CA, June 2019 (with Dianne Ezell, Oak Ridge National Laboratory)
- physics-based data analytics for characterization of natural and architected systems, *Society of Engineering Science Conference*, Minneapolis, MN, October 2021 (with Bojan Guzina, University of Minnesota); postponed due to COVID
- data-driven approaches to engineering mechanics, *Engineering Mechanics Institute Conference*, Johns Hopkins University, MD, June 2022
- Referee for:
 - SIAM Journal on Applied Mathematics
 - Geophysics
 - Materials Evaluation
 - IMA Volumes in Mathematics and its Applications
 - Journal of Applied Physics & Nanotechnology
 - Journal of Mechanical Systems & Signal Processing
 - Journal of Inverse Problems in Science & Engineering
 - Ultrasonics
 - Journal of Engineering Mechanics
 - ASME Journal of Computing and Information Science in Engineering
 - ASME Journal of Vibration and Acoustics
 - International Journal of Mechanics and Materials in Design
 - International Journal of Rock Mechanics and Mining Sciences

9. Selected Publications & Presentations:

- Pourahmadian F, Haddar H (2023). “Ultrasonic imaging in highly heterogeneous backgrounds”, *Proceedings of the Royal Society A*, accepted for publication 1/27/23
- Pourahmadian F (2021). “Experimental validation of differential evolution indicators for ultrasonic imaging in unknown backgrounds”, *Journal of Mechanical Systems and Signal Processing*, **161**, 108029.
- Pourahmadian F (2021). “Recent progress on inverse scattering in highly heterogeneous solids”, *6th Annual Meeting of SIAM-CSS*, Univ. of Kansas, KS.
- Pourahmadian F (2021). “Data-driven characterization of micromechanical evolution in highly scattering solids”, *14th World Congress on Computational Mechanics (WCCM XIV) and 8th European Congress on Computational Methods in Applied Science and Engineering (ECCOMAS 2020)*, Virtual.
- Pourahmadian F (2020). “Sampling-based approaches to laser ultrasonics”, *Society of Engineering Science Conference*, Virtual.

10. Briefly list the most recent professional development activities:

Engineering Mechanics Institute Conference, Johns Hopkins University
 SIAM-CSS conference, Oklahoma State University

ABET CV for Chris Senseney

1. **Name:** Christopher Senseney, PhD, P.E.
2. **Education:**
 - PhD Civil Engineering, Colorado School of Mines, 2011
 - M.S. Civil Engineering, University of Colorado-Boulder, 2004
 - B.S. Civil Engineering, United States Air Force Academy, 1997
3. **Academic experience:**
 - University of Colorado, Boulder, Colorado (2020-present), Department of Civil, Environmental and Architectural Engineering, Associate Teaching Professor, FT
 - United States Air Force Academy, Colorado (2013-2017), Department of Civil and Environmental Engineering, Assistant/Associate Professor, FT
4. **Non-academic experience:**
 - Kiewit Infrastructure Engineers, Englewood, Colorado (2018-2020), Senior Pavement Engineer, full-time
 - U.S. Air Force Civil Engineering Officer (1997-2017), various assignments
5. **Certifications or professional registrations:**
 - P.E. Ohio No. 7026
 - P.E. Colorado No. 53132
 - NCEES Record No. 1843093
6. **Current membership in professional organizations:**
 - American Society of Civil Engineers
 - ASTM
 - Society of American Military Engineers
7. **Honors and awards:**
 - Outstanding Academy Educator for top instructor in Department of Civil and Environmental Engineering, USAFA (2015-2016)
 - Highest Score on Professional Engineer Exam in Ohio (2005)
 - Company Grade Officer of the Year, 43rd Civil Engineering Squadron (2002)
 - Distinguished Graduate, Air Force Civil Engineer Basic Course (2001)
 - Bronze Star Medal, Defense Meritorious Service Medal, Meritorious Service Medal, Air Force Combat Action Medal (various years)
8. **Service activities (within and outside of the institution):**
 - Director, Kiewit Design-Build Scholarship Program, College of Engineering and Applied Science, CU-Boulder, 2020-present
 - ASCE Faculty Advisor, CU-Boulder, 2021-present
 - CEAE Curriculum Committee, CU-Boulder, 2020-present
 - Geotechnical Division Head, USAFA, 2014-2016
 - Department Cost Center Manager, USAFA, 2013-2017
 - Director of Curriculum, USAFA, 2017

- ASCE Faculty Advisor, USAFA, 2015-2017

9. Selected Publications & Presentations:

- Senseney, C.T., Duan, Z., Zhang, B., and Regueiro, R.A. “Combined Spheropolyhedral Discrete Element (DE) – Finite Element (FE) Computational Modeling of Vertical Plate Loading on Cohesionless Soil,” *Acta Geotechnica*, 2017, 12(3), 593-603.
- Senseney, C.T., Smith, P.J., Snyder, M.B. “Precast Concrete Paving Repairs at Vancouver International Airport,” *Transportation Research Record: J. Transportation Research Board*, 2021, No. 2675, Vol. 9, 439-448.
- Senseney, C.T. and Suermann, P.C. “Design, Construction and Monitoring of Concrete Roadway Pavement at Extremely Steep Longitudinal Slopes,” *International J. of Pavement Engineering*, 2021, 1-9.
- Mitchell, M.M., and Senseney, C.T. “Engineering Project Builds Skills and Showcases Ingenuity,” *Civil Engineering*, 2022, 92(6), 22-23.
- Senseney, C.T., Harvey, J.T., Butt, A.A., Meijer, J. “Recommended Approaches for Cradle-to-Gate Environmental Product Declarations (EPD) in ‘Buy Clean’ Procurement Policies for Civil Infrastructure Construction Materials”, *J. of Cleaner Production* (In review).

10. Briefly list the most recent professional development activities:

Transportation Research Board, Annual Meeting, Washington, D.C., January 8-12, 2023
 Climate Across the Curriculum Workshop, Univ. of Colorado Boulder, August 8-9, 2022
 Undocually Training, University of Colorado, Boulder, March 2, 2022.
 Transportation Research Board, Annual Meeting, Washington, D.C., January 9-13, 2022

ABET CV for Jeong-Hoon Song

1. **Name:** Jeong-Hoon Song

2. **Education:**

Ph.D., Theoretical and Applied Mechanics, Northwestern University, USA, 2008

M.S., Civil Engineering, Yonsei University, Korea, 2003

B.S., Civil Engineering, Yonsei University, Korea, 2001

3. **Academic experience:**

University of Colorado Boulder, Associate Professor (08/2021-Present) Full-time

University of Colorado Boulder, Assistant Professor (08/2014-08/2021) Full-time

University of South Carolina, Assistant Professor (01/2011-08/2014) Full-time

Northwestern University, Post-doctoral Fellow (06/2008-12/2010) Full Time

4. **Non-academic experience:** None

5. **Certifications or professional registrations:** None

6. **Current membership in professional organizations:**

Member, ASCE/EMI Computational Mechanics Committee

Member, American Society of Mechanical Engineers (ASME)

Member, American Society of Civil Engineers (ASCE)

Member, U.S. Association for Computational Mechanics (USACM)

Member, International Association for Computational Mechanics (IACM)

7. **Honors and awards:**

- U.S. Naval Research Laboratory, ONR Research Faculty Fellow (2014-2016)

8. **Service activities (within and outside of the institution):**

- Service to the scientific and engineering community: Dr. Song has organized, co-organized and chaired a number of conference mini-symposia. Most recently, in 2022, he co-organized the mini-symposium, entitled “Data-driven approaches to engineering mechanics”, American Society of Civil Engineers (ASCE) - Engineering Mechanics Institute Conference, Baltimore, Maryland.
- Dr. Song has been organized several special journal issues in the area of computational mechanics as guest and co-guest editors. Most recently, in 2017, he organized a special issue on “Computational modeling of material deterioration at various length scales” at International Journal of Fracture.

9. **Selected Publications & Presentations:**

- “A strong-form meshfree collocation method for modeling stationary cracks with frictional contact,” A. Almasi, Y.C. Yoon, T.Y. Kim, T. A. Laursen, J.H. Song, International Journal of Non-Linear Mechanics, 2023, 148: 10429.
- “Strong form meshfree collocation method for frictional contact between a rigid pile and an elastic foundation,” A. Almasi, T.Y. Kim, and J.H. Song, Engineering with Computers, 2022, doi: 10.1007/s00366-022-01673-y.

- “Strong form collocation method for solidification and mechanical analysis of polycrystalline materials,” A. Almasi, A. Beel, T.Y. Kim, J. G. Michopoulos and J.H. Song, ASCE Journal of Engineering Mechanics, 2019, 145, 04019082.
- “Non-nodal extended finite element method (NXFEM) for modeling crack with four-node quadrilateral elements,” I. Asareh and J.H. Song, ASCE Journal of Engineering Mechanics, 2019, 145, 04019081.
- “Phase field simulations of coupled microstructure solidification problems via the strong form particle difference method,” J.H. Song, Y. Fu, T.Y. Kim, Y.C. Yoon, J.G. Michopoulos, and T. Rabczuk, International Journal of Mechanics and Materials in Design, 2018, 14, 491-509.

10. Briefly list the most recent professional development activities:

Contributions to the engineering science: Dr. Song’s research is based on strong computational efforts combined with theoretical and applied mechanics of solids and material science. He has published over 55 peer-reviewed journal publications in this area with an h-index of 23 (ISI Web of Science, 2022).

Service to the scientific and engineering community: Dr. Song has organized, co-organized and chaired a number of conference mini-symposia. Most recently, in 2022, he co-organized the minisymposium, entitled “Data-driven approaches to engineering mechanics”, American Society of Civil Engineers (ASCE) - Engineering Mechanics Institute Conference, Baltimore, Maryland.

Dr. Song has been organized several special journal issues in the area of computational mechanics as guest and co-guest editors. Most recently, in 2017, he organized a special issue on "Computational modeling of material deterioration at various length scales" at International Journal of Fracture.

Dr. Song has been awarded for the office of naval research (ONR) summer faculty fellowship in 2014-2016, and worked at the Center for Computational Materials Science at the U.S. Naval Research Laboratory to establish the integrated computational materials engineering (ICME) approach for metal powder-based additive manufacturing.

ABET CV for Cristina Torres-Machi

1. **Name:** Cristina Torres-Machi

2. **Education:**

Ph.D., Civil Engineering and Urban Planning, Polytechnic University of Valencia, Spain, 2015

Ph.D., Engineering Science, Catholic University of Chile, Chile, 2015

M.S., Planning and Management in Civil Engineering, Polytechnic University of Valencia, Spain, 2012

B.S., Civil Engineering, Polytechnic University of Valencia, Spain, 2008

3. **Academic experience:**

University of Colorado Boulder, Assistant Professor, 2017- present, full-time

University of Waterloo, Canada, Research Associate, 2016-2017, full-time

Polytechnic University of Valencia, Spain, Assistant Professor, 2011-2016, full-time

Catholic University of Chile, Chile, Research Assistant, 2012-2015, part-time

4. **Non-academic experience:**

CMD Domingo y Lazaro Ingenieros, Structural Engineer, 2009-2011, full-time

Dragados, Assistant Site Manager, 2007-2009, full-time

5. **Certifications or professional registrations:** None

6. **Current membership in professional organizations:**

American Society of Civil Engineers (ASCE), member

7. **Honors and awards:**

- Ross B. Corotis Engineering Endowment (2022 – current)
- Beavers Professorship of Construction Engineering (2021 – current)
- Frontiers of Engineering, US-EU Symposium Participant, National Academies of Engineering (2022)
- Early Career Award, Dept. Civil, Environmental, and Architectural Eng., CU Boulder (2022)
- Erasmus + KA107 mobility grant for short exchange at Polytechnic University of Valencia (2021)
- Outstanding Reviewer, ASCE Journal of Infrastructure Systems (2020)
- Young Resilience Fellowship, 4TU Centre for Resilience Engineering, The Netherlands (2020)

8. **Service activities (within and outside of the institution):**

External

- Vice-chair, Transportation Research Board (TRB) Technical Committee on Transportation Asset Management (AJE30) (2020 – present); member (2019 – present).
- Secretary of Executive Committee, ASCE Construction Research Conference, Construction Institute (2022 – present).

- Vice-chair, ASCE Infrastructure Systems, Transportation & Development Institute (2019 – 2022); member (2017 – present).
 - Panel reviewer in National Science Foundation programs such as Strengthening American Infrastructure (SAI), Civil Infrastructure Systems (CIS), etc.
 - Journal review (e.g., *Automation in Construction*, *Journal of Infrastructure Systems*).
- Internal CU Boulder*
- Graduate Committee, Recruiting and Admissions, Dept. of Civil, Environmental, and Architectural Engineering, University of Colorado Boulder (Fall 2018-Spring 2022).
 - Search Committee, Tenure-track faculty in Construction Engineering and Management, Dept. of Civil, Environmental, and Architectural Engineering, University of Colorado Boulder (Fall 2022-present).

9. Selected Publications & Presentations:

- Bashar, M.; **Torres-Machi, C.** (2022) Deep Learning Framework for Estimating Pavement Roughness using Synthetic Aperture Radar Data. *Automation in Construction*, 142, 104504, DOI: 10.1016/j.autcon.2022.104504
- Seites-Rundlett, W.; Bashar, M.; **Torres-Machi, C.**; Corotis, R. (2022) Combined Evidence Model to Enhance Pavement Condition Prediction from Highly Uncertain Sensor Data. *Reliability Engineering & System Safety*, 217, 108031, DOI: 10.1016/j.ress.2021.108031
- Bashar, M.; **Torres-Machi, C.** (2021) Performance of Machine Learning Algorithms in Predicting Pavement International Roughness Index. *Transportation Research Record: Journal of the Transportation Research Board*, 2675(5) 226–237, DOI: 10.1177/0361198120986171.
- Gaikwad, S.; Calahorra-Jimenez, M.; Molenaar, K.; **Torres-Machi, C.** (2021) Challenges in Engineering Estimates for Best-Value Design-Build Projects: An Analysis of Bid-Dispersion in US Highway Projects. *Journal of Construction Engineering and Management*, 147(7), 04021065, DOI: 10.1061/(ASCE)CO.1943-7862.0002104.
- Seites-Rundlett, W.; Garcia-Bande E.; Alvarez-Mingo, A.; **Torres-Machi, C.**; Corotis, R. (2020) Social Indicators to Inform Community Evacuation Modeling and Planning. *ASCE-ASME Journal of Risk and Uncertainty in Engineering Systems, Part A: Civil Engineering*, 6(3):03120001, DOI:10.1061/AJRUA6.0001069.

10. Briefly list the most recent professional development activities:

Participant in Game Changer Academies (CGCA) organized by the Civil, Mechanical and Manufacturing Innovation (CMMI) Division of the National Science Foundation. December 2022 – May 2023. 35 hrs.

Participant in ExCEED (Excellence in Civil Engineering Education) Teaching Workshop organized by ASCE. Summer 2019. 40 hrs.

ABET CV for Yunping Xi

1. Name: Yunping Xi

2. Education:

Ph.D. in Structural Engineering, Northwestern University, Evanston, IL. (1991)
M.S. in Structural Engineering, Central Research Inst. of Building and Construction, Beijing, China (1985)
B.S. in Civil Engineering, Beijing Institute of Civil Engineering and Architecture, Beijing, China (1982)

3. Academic experience:

2005 – Present Professor, University of Colorado at Boulder
2000– 2005 Associate professor, University of Colorado at Boulder
1997– 2000 Assistant professor, University of Colorado at Boulder
1993– 1996 Assistant professor, Drexel University
1991– 1993 Research Scientist, Northwestern University
1987– 1988 Visiting Scholar, Northwestern University

4. Non-academic experience:

1985-1987 Structural engineer, Beijing Central Research Inst of Bldg & Construction
1982-1983 Structural engineer, Beijing Design Institute of Building and Construction

5. Certifications or professional registrations: None

6. Current membership in professional organizations:

A member of the committee on Properties of Materials, Engineering Mechanics Institute (EMI), American Society of Civil Engineers (ASCE).
Member of committee on Experimental Analysis and Instrumentation, EMI, ASCE.
A member of the International Committee on Irradiated Concrete (ICIC).

7. Honors and awards:

- *Eckel Award 2018*. Department of Civil, Environmental and Architectural Engineering (CEAE), University of Colorado Boulder (CU-Boulder).
- Recipient of *2010 Faculty Fellowship* at CU-Boulder.
- *Research development award 2004*. Department of CEAE, CU-Boulder.
- *Young Researcher's award 1998-1999*. Department of CEAE, CU-Boulder.

8. Service activities (within and outside of the institution):

- The chair of the committee on Properties of Materials (2003-2007), EMI, ASCE.
- The chair (2013-2014), vice chair (2012), and past chair (2015) of the committee on Experimental Analysis and Instrumentation, EMI, ASCE.
- The administrator of Colorado Local Technical Assistance Program (sponsored by the U.S. Federal Highway Administration, Colorado Department of Transportation, and University of Colorado at Boulder) (1998-2019). The coordinator of SESM Group (2002-2003 and 2022-present) in Dept. of CEAE at CU- Boulder.
- A co-director of The Center for Infrastructure, Energy, and Space Testing (CIEST) at

CU- Boulder (2022-present).

- A member of First Level Review Committee of College of Engineering (2012 – 2015 and 2022-present) at CU-Boulder.
- A member of Program & Students Committee, Dept. of CEAE at CU-Boulder (2021-present).
- The executive committee member of Dept. of CEAE representing Structural Engineering and Structural Mechanics (SESM) Group (2005 – 2011).

9. Selected Publications & Presentations:

- Li, L., Hubler, M., Abdelrahman, M., and Xi, Y. (2021) “Numerical Modeling of the Injection of Nanoparticles in Saturated Cementitious Materials by Using Electromigration Method”. *J. of Eng. Mech.*, ASCE, 147(9), [https://doi.org/10.1061/\(ASCE\)EM.1943-7889.0001954](https://doi.org/10.1061/(ASCE)EM.1943-7889.0001954).
- Wang, Y., Bai, Y., and Xi, Y. (2021) “Analytical solutions of moisture-chloride ion coupled transport in unsaturated concrete”, *Journal of the American Ceramic Society*, 104(11), 5883-5897, <https://doi.org/10.1111/jace.17973>.
- Li, L., Zhang, Y., Hubler, M., and Xi, Y. (2021) “Experimental Study on Nanoparticle Injection Technology for Remediating Leaks of CO₂ Storage Formation”, *Journal of Petroleum Science and Engineering*, <https://doi.org/10.1016/j.petrol.2021.108829>.
- Jing, Y., and Xi, Y. (2021) “Modeling long-term distribution of fast and thermal neutron fluence in degraded concrete biological shielding walls”, *Construction and Building Materials*, <https://doi.org/10.1016/j.conbuildmat.2021.123379>.
- Li, L., Hubler, M., and Xi, Y. (2020) “Theoretical Modelling on Chemical Composition and Mechanical Properties of Well Cement under Carbonation Reactions”, *Journal of Cleaner Production*, 276, 124270, <https://doi.org/10.1016/j.jclepro.2020.124270>.
- Li, L., Hubler, M., and Xi, Y. (2020) “Modelling the Corrosion of Steel Casing and the Damage of Well Cement in a Borehole System”, *Construction and Building Materials*, <https://doi.org/10.1016/j.conbuildmat.2020.119701>.
- Damien, D., Wang, Y., and Xi, Y. (2019) “Prediction of Modulus of Elasticity of Cementitious Materials Based on Multiphase and Multiscale Micromechanics Theory”, *J. of Eng. Mech.*, ASCE, 145(10): 04019074, DOI: 10.1061/(ASCE)EM.1943-7889.0001650.
- Jing, Y., and Xi, Y. (2019) “Long-term Neutron Radiation Levels in Distressed Concrete Biological Shielding Walls”, *Journal of Hazardous Materials*, 363, 376-384.
- Abdelrahman, M., and Xi, Y. (2018) “The Effect of w/c Ratio and Aggregate Volume Fraction on Chloride Penetration in Nonsaturated Concrete”, *Construction and Building Materials*, 191, 260-269.

10. Briefly list the most recent professional development activities:

ICIC virtual webinar, Nov. 16-17, 2021

International conf. On plasticity, damage & fracture, Punta Cana, Dominican Rep, Jan., 2023

ABET CV for Yida Zhang

1. **Name:** Yida Zhang

2. **Education:**

PhD Northwestern University (2016), Civil and Environmental Engineering
MS Louisiana State University (2012), Civil and Environmental Engineering
BS Zhejiang University (2010), Civil and Environmental Engineering

3. **Academic experience:**

2016-Current: Assistant Professor, Dept. of Civil, Environmental, and Architectural Eng., University of Colorado Boulder, Boulder, CO.

2012-2016: Doctoral Researcher, Department of Civil and Environmental Engineering, Northwestern University, Evanston, IL.

4. **Non-academic experience:** None

5. **Certifications or professional registrations:** None

6. **Current membership in professional organizations:**

Engineering Mechanics Institute of ASCE, Unsaturated Soils of ASCE, ARMA

7. **Honors and awards**

8. **Service activities (within and outside of the institution):**

- *Poromechanics* committee, EMI, ASCE: Member (5/21-present), Vice Chair (12/20-)
- *Granular materials* committee of the EMI of ASCE: Member (6/17 – present)
- *Modeling Inelasticity and Multiscale Behavior* EMI, ASCE: Member (5/18-present)
- *Unsaturated Soils* committee, Geo-Institute of the ASCE: Member (9/16 – present)
- *Underground Storage and Utilization* committee of ARMA: Member (7/20-Present)
- Editorial Board Member of *Géotechnique Letters* (9/18 – present)
- Proposal review: *National Science Foundation (NSF) - Geotechnical Engineering and Materials*, *NSF- Fluid Dynamics*, *NSF - Geophysics*, *NSF - Particulate & Multiphase Process*, *NSF - Major Research Instrumentation*, *U.S. Department of Energy (DOE)- Basic Energy Sciences - Geosciences Program*, *American Chemical Society (ACS) Petroleum Research Fund (PRF)*, *Hong Kong Research Grants Council (RGC)*.
- Journal article review: *Journal of Mechanics and Physics of Solids*, *Journal of Engineering Mechanics*, *Journal of Geophysical Research: Solid Earth*, *Geophysical Research Letters*, *Fuel*, *Géotechnique*, *Journal of Geotechnical and Geoenvironmental Engineering*, *International Journal of Rock Mechanics and Mining Sciences*, *International Journal for Numerical and Analytical Methods in Geomechanics*, *Rock Mechanics and Rock Engineering*, *Engineering Fracture Mechanics*, *Computers and Geotechnics*, *Granular Matter*, *Journal of Infrastructure Systems*, *Geotechnical Testing Journal*, *International Journal of Damage Mechanics*, *Engineering Geology*, *Geomechanics for Energy and Environment*, *Mechanics Research Communications*, *Journal of Rock Mechanics and Geotechnical*

9. Selected Publications & Presentations:

- Nakagawa^{*}, S, Zhang, Y., Eskandari-Ghadi[†], M., Vasco, D.W. (2023) Corrections of Double-Torsion (DT) subcritical crack growth tests for crack profile geometry. *Theoretical and Applied Fracture Mechanics* 124, 103752, DOI: 10.1016/j.tafmec.2023.103752.
- Eskandari-Ghadi, M.[†], Nakagawa, S., Hang, D., Pride, S., Gilbert, B., Zhang, Y.^{*} (2022) The role of surface forces in environment-enhanced cracking of brittle solids. *Journal of Mechanics and Physics of Solids* 172, p.105162, DOI: 10.1016/j.jmps.2022.105162
- Hu, Z.[‡], Li, J., Zhang, Y.^{*}, Yang, Z.X., Liu, J. (2022) A CFD-DEM study on the suffusion and shear behaviors of gap-graded soils under stress anisotropy. *Acta Geotechnica*. Published online. DOI: 10.1007/s11440-022-01755-7
- Sisodiya, M.[†], Zhang, Y.^{*} (2021) A rate-dependent directional damage theory for brittle rocks considering the kinetics of microcrack growth. *Rock Mechanics and Rock Engineering* 55(5), 2693–2710, DOI: 10.1007/s00603-021-02577-x.
- Singh, S.[†], Zurakowski, Z., Dai, S., Zhang, Y.^{*} (2021) Effect of grain crushing on hydraulic conductivity of tailings sand. *Journal of Geotechnical and Geoenvironmental Engineering* 147(12), DOI: 10.1061/(ASCE)GT.1943-5606.0002667.
- Hu, Z.[‡], Yang, Z.X.^{*}, Zhang, Y. (2020) CFD-DEM modeling of suffusion effect on undrained behavior of internally unstable soils. *Computers and Geotechnics* 126, 103692, DOI: 10.1016/j.compgeo.2020.103692.
- Hu, Z.[‡], Zhang, Y.^{*}, Yang, Z.X. (2019) Suffusion-induced evolution of mechanical and microstructural properties of gap-graded soils using CFD-DEM. *Journal of Geotechnical and Geoenvironmental Engineering* 146(5), 04020024, DOI: 10.1061/(ASCE)GT.1943-5606.0002245.
- Zhang, Y.^{*}, Zhou, X.[†], Wen, Y.[†] (2019) A constitutive theory for sand based on the concept of critical fabric surface. *Journal of Engineering Mechanics* 146(4), 04020019, DOI: 10.1061/(ASCE)EM.1943-7889.0001741.
- Zhang, Y.^{*} (2018). Mechanics of adsorption-deformation coupling in porous media. *Journal of the Mechanics and Physics of Solids* 114, 31-54.

10. Briefly list the most recent professional development activities:

Conference Session Chair:

o *Numerical Modeling of Civil Rock Engineering Projects*, with Seunghee Kim, ARMA 2018, Seattle, June 2018.

o *Multiscale geomechanics*, with Jesse Hampton, ARMA 2019, New York, June 2019.

o *Numerical Modeling in Rock Mechanics focused on Civil Engineering Projects*, with Xiaoyu Song, ARMA 2020, Golden, June 2020.

Conference Track lead

o *Special topics*, with Michelle Lee Barry and Marco Salviato, EMI 2019, Caltech, June 2019.

o *Interdisciplinary track*, with Shugang Wang, ARMA 2021, Houston, June 2021

APPENDIX C - EQUIPMENT

The major pieces of equipment used by the civil engineering program in courses to support instruction are summarized in the tables below.

Course	Major Equipment Used
AREN 2120 – Fluid Mechanics & Heat Transfer	-20+ Hobos for air temperature, relative humidity and lighting test
AREN 3010 – Energy Efficient Building	-Complete blower-door test kits (2 sets) -Microenvironment test stations (2 sets), with each including: <ul style="list-style-type: none"> o 5 temperature sensors (TMC6-HD) o 1 temperature sensor (TMC20-HD) o 4 solar radiation shields (RS3-B) o 2 data loggers (UX120-006M) o 1 weatherproof box o 1 mounting pole (EZ NP 72-200)
AREN 3540 – Illumination I	- Extech illuminance meters EA-33 (20) - Konica Minolta luminance meter LS-100 (1) - Konica Minolta spectrophotometer CL-500 (1)
AREN 4110 – HVAC Design	- IR thermographic camera - Blower door

AREN 4550 – Illumination II	<ul style="list-style-type: none"> - Minolta illuminance meters T-1 (10) - Minolta luminance meter LS-100 (1) - Spectrometer - Various lamps and lamp holders - Manual dimmers (1)
AREN 4010 –HVAC System Modeling Ctl	-Direct digital control (DDC) modules to teach development of HVAC control strategies for air handling units and chilled water plants
AREN 4830 – Sustainable Materials & Structures	-Instron machine in CIEST laboratory
AREN 4130 – Optical Design	<ul style="list-style-type: none"> - Konica Minolta illuminance meters T-10 - Konica Minolta luminance meter LS-100 - CL-500A Konica Minolta Spectrometer - Omega HH309A digital thermometer - 36” Integrating sphere - Optical bench & various mounting hardware - Manually operated, 8’ arm, goniophotometer - Various LED modules and luminaires - Lambda 0-150V DC power supply - Interpower 500VA multi-frequency AC power supply - Elgar 120V AC power supply - Laser cutters in ITLL - 3D printer in ITLL

AREN 4350 – Advanced Lighting Design	<ul style="list-style-type: none"> - Moveable ceiling in lighting lab - ETC programmable 7-color LED theatrical luminaires (4) - ETC Source Four Mini theatrical luminaires (6) - Theatrical tripod stands with T-Bar (8) and floor stands (8) - Theatrical lamp holders with options for gels and gobos (24) - Various beam-angle lamps and lamps holders - Manual dimmers (10)
AREN 4620, Adaptive Lighting Systems	<ul style="list-style-type: none"> ● Prototyping kit that includes an Arduino, sensors, LEDs, and connectors (1 kit per student) ● Mock office space with 12 RGBW LED luminaires (1) with a DMX controller (1) and laptop (1) ● Seven-channel theatrical LED luminaires (6) with DMX controllers (3) ● Proprietary control system setups that include luminaires, sensors, and controllers (4 unique systems) ● Miscellaneous switches, sensors, and luminaires for in-class demonstrations
AREN 4580, Daylighting	<ul style="list-style-type: none"> ● Illuminance meters (1 per student) ● Luminance meter (1) ● Spectrometer (1) ● DSLR camera and tripod (1 each) ● Virtual reality headset and gaming laptop (1 each)

CVEN 2012 Geomatics	<ul style="list-style-type: none"> -Tripods – ca. 10 Wild type (5/8X11 screw), ca. 4 Kern type -Automatic Levels – 8, including Leica, K&E, Wild types -Theodolites – 8 electronic theodolites -Total Stations: 6 Leica: 4 “Builder,” 2 earlier models, 4 Nikon -Corner prism EDM reflectors – ca. 8 useable -Stadia Rods – 7 -Range poles/reflector poles - 3 -Tapes: 6 fiberglass, 100’ and 200’ -Tapes: 4 metal, mostly with broken tips but still usable -Metal detector -Misc. Flagging and marking equipment -GPS: 24 Leica GS14 antennas and one Leica CS20 controller, plus accessories for base station/RTK rover configuration -Leica 3D Laser Scanner
CVEN 3161- Mechanics of Materials I	<ul style="list-style-type: none"> -MTS universal testing machine for tension and compression testing of structural and geological materials, with capacities of 500 kN -Tinus Olsen Torsional Testing Machine with 2000 in-lb capacity -Concrete mixer, scale -Whitemann displacement gage, dial gages, strain gages
CVEN 3313 Fluids	<ul style="list-style-type: none"> -Hydrostatic force on plane surface apparatus -Vertical tank with orifice apparatus -Venturi, orifice flow meter, manometer -Jet apparatus with target and weights

CVEN 3424 Water & Wastewater Treatment	<ul style="list-style-type: none"> -Phipps & Bird jar test apparatus -Turbidimeter
CVEN 3323 Hydraulics	<ul style="list-style-type: none"> -rod, tape measure, waders, flow meters -Armfield hydraulics bench w/energy losses apparatus, bicycle pump -Armfield hydraulics bench with weir module, hook and point gauge -Armfield multi-purpose teaching flume, broad-crested weir
CVEN 4414 Water Chemistry Lab	<ul style="list-style-type: none"> -Electronic balance, high range (Ohaus model Navigator NOB110) - 1 -Electronic balance, low range (Ohaus model Navigator NO2120) – 1 -Inductively coupled plasma-atmoic emission spectrophotometer (Vairan model Liberty Series II Axial) – 1 -Visible spectrophotometers (Spectronic model 20D+) – 4 -Coagulation Jar Testers (Phipps & Bird model Standard) - 4 -pH meters (Thermo-Orion model 250Aplus) – 4 -pH electrodes (Thermo-Irion triode combination) – 4 -Colorimetric Test Kits (Hach model DR/890) - 4 -Conductivity meters (Thermo-Orion model 115Aplus) - 4 -Drying oven (Fisher model Isotemp 506G) – 1 -Muffle furnace (Fisher model Iostemp programmable) – 1 -Microscopes (Leitz model IN200) – 2 -Heated stir plates (Corning model PC-420) – 4 -Computers (Dell Optiplex GX270) – 5 -Data acquisition boards (National Instruments) - 4 -20 Augmented reality Goggles (Merge Headsets, location: SEEC S274)

CVEN 4161 – Mechanics of Materials II	<ul style="list-style-type: none"> -MTS universal testing machine for tension and compression testing of structural and geological materials, with capacities of 500 kN. -Beam testing setup. -Whitemann displacement gage, dial gages, strain gages.
CVEN 3708 Geotechnical Engineering 1	<ul style="list-style-type: none"> -Triaxial cells and consolidometers -Proctor and modified Proctor test equipment -Atterberg limit apparatus -Constant head and falling head permeability setup -Mechanical sieve shaker, sieve stacks, and hydrometers
CVEN 3718 Geotechnical Engineering 2	<ul style="list-style-type: none"> -Direct shear test machine with shear box, weights, displacement gauges -Triaxial test cells with load cells, pressure gauges, LVDT, computer -Instructional Centrifuge and demonstration models, data acquisition system

APPENDIX D – INSTITUTIONAL SUMMARY

A. The Institution

a. Name and address of the institution:

The University of Colorado Boulder
College of Engineering and Applied Science
422 UCB
Boulder, Colorado 80309-0422

b. Name and title of the chief executive officer of the institution:

Todd Saliman - President of the University of Colorado System
Philip P. DiStefano - Chancellor of the Boulder Campus
Russell L. Moore - Provost and Executive Vice Chancellor for Academic Affairs
Keith Molenaar - Dean of the College of Engineering and Applied Science

c. Name and title of the person submitting the self-study report:

Submitted by:

Wil V. Srubar III, Associate Professor and Associate Chair of Undergraduate Education
Department of Civil, Environmental, and Architectural Engineering
College of Engineering and Applied Sciences
University of Colorado Boulder
Boulder, Colorado 80309
wsrubar@colorado.edu

Karl Linden, Professor and Chair
Department of Civil, Environmental, and Architectural Engineering
College of Engineering and Applied Sciences
University of Colorado Boulder
Boulder, Colorado 80309
karl.linden@colorado.edu

Keith Molenaar, Dean
College of Engineering and Applied Science
University of Colorado Boulder
Boulder, Colorado 80309-0422
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Contact for ABET matters:
Vanessa Dunn
Director of Assessment, Analytics and Accreditation

College of Engineering and Applied Science
Boulder, CO 80309-0422
303-492-8849
Vanessa.Dunn@colorado.edu

Rhonda Hoenigman, Associate Dean for Education
College of Engineering and Applied Science
University of Colorado Boulder
Boulder, Colorado 80309-0422
303-492-0084
Rhonda.Hoenigman@colorado.edu

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 Colorado Boulder is accredited by the Higher Learning Commission (HLC), which is part of the North Central Association of Colleges and Schools (NCA). The NCA is a membership organization of colleges and schools in nineteen states ranging from Michigan to Arizona, including Colorado. The HLC is recognized by the US Department of Education (USDE) to accredit degree-granting higher education institutions. The University of Colorado at Boulder has been accredited since 1913. Every ten years, a team of leading external educators visit the University's campus to evaluate programs, policies, and practices and to provide recommendations for continuous improvement. The most recent review took place in December 2019 and the Institutional Actions Council of the Higher Learning Commission voted to continue accreditation for the University of Colorado Boulder. For more information, see [Institutional Accreditation | Accreditation & State Authorization | University of Colorado Boulder](#). The most recent self-study is at [University of Colorado Final Report](#)

B. Type of Control

The University of Colorado is a state-supported institution governed by an elected Board of Regents under the Colorado Commission on Higher Education.

C. Educational Unit

a. Campus Administration

The Dean of the College of Engineering and Applied Science reports to the Provost and Executive Vice Chancellor for Academic Affairs, who reports to the Chancellor and Chief Executive Officer of the Boulder Campus. The Chancellor and Chief Executive Officer report to the President of the University of Colorado system. Additional details

can be found at [Chancellor's Administrative Organization | Office of the Chancellor | University of Colorado Boulder](#)

b. College Administration

The Chief Executive Officer of the College of Engineering and Applied Science is the Dean, Keith Molenaar. Additional College Leadership:

- Associate Dean for Undergraduate Education, Rhonda Hoenigman
- Associate Dean for Students, Mary Steiner
- Assistant Dean for Access, Inclusion, and Student Programs, Terri Wright
- Associate Dean for Research, Shideh Dashti
- Associate Dean for Graduate Education, Charles Musgrave
- Associate Dean for Faculty Advancement, Fernando Rosario-Ortiz
- Assistant Dean of Strategic Initiatives, Medford Moorer
- Assistant Dean for Operations, Cherie Summers
- Associate Dean for Digital Education, William Kuskin
- Senior Director of Alumni Engagement and Donor Relations/Interim Advancement Lead, Kevin Lobdell

D. Academic Support Units

Several other departments and programs, including Applied Mathematics, Physics, Chemistry, the Herbst Program of Ethics and Society, and the Program for Writing and Rhetoric, support the degree programs in the College. These supporting units also teach courses for other majors throughout the University. The names and titles of the individuals responsible for these units are as follows:

- Applied Mathematics, Keith Julien, Department Chair
- Physics, Michael Ritzwoller, Department Chair
- Chemistry, Wei Zhang, Department Chair
- Herbst Program for Engineering, Ethics & Society, Diane Sieber, Program Director
- Program for Writing and Rhetoric, John Stevenson, Director

The courses provided by these academic support units are regularly reviewed by the Undergraduate Education Council (UEC), chaired by the Associate Dean for Undergraduate Education. The Council is composed of the associate chairs (or curriculum committee chairs) or their designee for each program, the undergraduate staff advisors for each department, and other program directors and Dean's office representatives. This group meets regularly throughout the year to coordinate matters of common interest and concern for the College's undergraduate programs.

E. Non-academic Support Units

There are several programs in the College of Engineering and Applied Science that support student success, including:

- Broadening Opportunity through Leadership and Diversity ([BOLD](#)) provides scholarship, resources, and community for students who are underrepresented in STEM (Amy Moreno, Director)
- [Academic Coaching](#) supports the academic, personal, and career success of engineering students (Alana Davis-Delaria, Assistant Director)
- [Engineering Ambassadors](#) supports new and prospective students (Chris Anderson, Director of Transfer Pathways and Amanda Parker, Senior Director of Enrollment Management)
- The [Engineering Residential Community](#) is a living-learning community for all first-year engineering students that emphasizes academics, belonging and wellness (Scot Douglas, Faculty Director)

Several campus-wide support units also serve undergraduate students and programs in the College of Engineering and Applied Science, including:

- Gemmill Engineering, Math and Physics Library (Emily Dommermuth, Engineering, Science and Design Librarian)
- Career Services (Lisa Lovett, Director)
- Office of the Registrar (Kristi Wold-McCormick, Assistant Vice Provost) and Office of Financial Aid (Ofeila Morales, Director)
- Center for Inclusion and Social Change (Amanda Linsenmeyer, Director)

F. Credit Unit

One semester credit normally represents one class hour or two laboratory hours per week. The campus operates year-round, with fall and spring semesters of 16 weeks each, a 10-week summer session, a three-week "Maymester" academic period between the spring semester and summer session, and a three-week "Augmester" academic period between the summer session and fall semester. All programs require 128 semester hours to graduate.

G. Tables

Table D-1. Program Enrollment and Degree Data**Name of the Program: Civil Engineering**

	Academic Year		Enrollment Year Class variable in census					Total Underg rad	Total Grad	Degrees Awarded			
			1st	2nd	3rd	4th	5th			Associates	Bachelors	Masters	Doctorates
Current Year	22-23	FT	33	47	38	58	21	197	111		47	41	8
		PT	0	1	0	0	6	7	10				
1 year prior to current year	21-22	FT	28	34	47	61	35	205	118		70	39	13
		PT	1	0	3	2	4	10	11				
2 years prior to current year	20-21	FT	45	32	48	70	29	224	118		68	40	19
		PT	2	0	2	4	6	14	13				
3 years prior to current year	19-20	FT	36	48	58	64	26	232	131		61	50	14
		PT	0	0	1	1	8	10	12				
4 years prior to current year	18-19	FT	40	42	55	69	33	239	162		63	63	21
		PT	0	2	0	1	1	4	14				

* Counts of active majors for students enrolled at fall census, over time. These are counts for major codes, NOT departments.

** Students with two majors are counted twice (once in each major).

*** Students in a combined bachelor's/master's program are counted only once and in the career for which they're enrolled for the term (these students were previously once in each career). Other students enrolled in multiple careers are counted in each career.

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: Civil Engineering

Year¹: 2023

	HEAD COUNT		FTE ²
	FT	PT	
Administrative ²	0	5	5
Faculty (tenure-track) ³	44	0	44
Other Faculty (excluding student Assistants)	37	41	78
Student Teaching Assistants ⁴	30	1	31
Technicians/Specialists	1	0	1
Office/Clerical Employees	9	2	11
Others ⁵			

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).

APPENDIX E – 2022-23 SENIOR DESIGN PROMPT

**CVEN 4899 SENIOR DESIGN
SPRING 2023**

**Request for Proposals (RFP)
Project Description and Design Problem**



Gross Reservoir Expansion Project



DESIGN-BUILD REQUEST FOR PROPOSALS (RFP)

Thank you for your interest in the Denver Water Gross Reservoir Expansion Project. We are excited to work with you during this design-build competition. Your progress in the Civil Engineering program at CU Boulder has automatically prequalified you for this opportunity. This RFP will describe the project and the design-build competition in detail.

Name of Project: Denver Water Gross Reservoir Replacement Project
Gross Dam Road, Golden, CO



Client(s): Denver Water
Primary Contact: Jeff Martin, P.E., PMP
Program Manager

Engineering Lead – AECOM / Stantec

Construction Lead – Kiewit-Barnard

Note to students: Client representatives are volunteering their time to participate with you on this important project. While they are very interested in responding to your questions and needs during the course of the semester, please respect their time. Each student team should delegate a team leader who can consolidate and coordinate questions to be sent to the TA first. The TA will subsequently coordinate with the Faculty and Client. Please do not contact the client directly!

A. Project Overview:

The Gross Reservoir Expansion Project is crucial to providing a secure water future to Denver Water's customers and protecting against potential catastrophic events such as fires, landslides, drought, and infrastructure failures which could impact the ability for Denver Water to deliver water to the Front Range. With demand expected to increase in the coming years, expanding Gross Reservoir will add a

new element of sustainability to Denver Water's multi-pronged approach to meet our customers' future needs which include conservation, recycled water, and developing additional supply.

The project has the following primary objectives:

- Raise the existing Gross Reservoir Dam to provide redundancy and increased capacity at Gross Reservoir. The raised dam spillway height shall be fixed at elevation 7406, as allowable by permit.
- Develop a new site plan at the dam to include access roads, parking areas, security and public viewing
- Reduce project costs through innovative material sourcing and construction means & methods
- During construction, minimize the impact to local residents near the project site and those impacted on haul routes
- Establish a secure dam site which meets or exceeds the security criteria established by Denver Water, during and after construction

B. Services Requested:

Denver Water is seeking an integrated design/build firm to perform all required services to raise the dam at Gross Reservoir. Services shall include, but are not limited to, the following:

1) General

- Overall Site Plan
- Written narratives with design calculations
- Design alternatives and cost saving recommendations
- A written narrative describing security measures during construction and after project completion, including threats and security features (fencing, gates, CCTV, signage, etc.)
- Drawing package – The following list of drawings represents the minimum sheets to be provided. Additional sheets may be identified as the design progresses -
 - G1.X - Cover sheet, vicinity map and drawing index
 - C1.X – Overall Site Plan
 - C1.X – Site Plan - New and Existing Reservoir Water Limits/Extents
 - C1.X - Demolition Plan (Drawing in plan view identifying all demolition)
 - C1.X – Tree Clearing Plan
 - C4.X – Rock Fall Mitigation Plan and Details
 - C2.X - Site Section(s)
 - C2.X – Subsurface Soil Profile
 - C2.X – Excavation Plan and Cross Sections
 - C2.X – Grading Plan
 - C2.X - Erosion Control Plan and Details
 - C5.X – Spillway Crest, Chute and Energy Dissipation Details
 - C5.X – Outlet Works Details (if necessary)
 - S1.X – Foundation Plan

- S1.X – Abutment Plan
- S1.X – Dam Raise Geometry
- S2.X – Dam Structure Elevations
- S3.X – Foundation Details
- S3.X – Abutment Details
- S3.X – Dam Raise Details
- S3.X – Spillway Details
- S5.X – Typical Details at New/Existing Dam Interface

2) Water

- Given the permitted spillway height of 7406, analyze flood routing to determine the crest height, spillway width and ultimate water surface elevation. Provide an analysis showing various spillway widths versus crest heights.
- Determine increased reservoir volume at new dam crest and spillway crest elevations and model the associated water levels in the existing topography
- For the spillway, identify multiple alternative energy dissipation measures (stepped chute, flip bucket, plunge pool, stilling basin, etc.) and perform a hydraulic analysis for each.
- Provide a final recommendation and design the spillway including the configuration, spillway crest, chute and energy dissipation. Determine the maximum discharge flow rates of the proposed spillway.
- Perform a hydraulic grade line analysis of the existing outlet works systems (Auxiliary and Primary) for the new normal and maximum water surface levels, El. 7406 and El. 74XX (TBD) respectively. The analysis should consider all aspects of the as-built system including the trash racks, inlets, tunnels and pipes. Actual system pressure should be analyzed and compared against allowable pressure of each system component. Provide recommendations for any modifications if necessary.
- Denver Water intends to operate the existing turbines and generators under the new reservoir normal water surface level El. 7406. Design a pressure reducing valve to lower the head seen by the turbines (for the new normal water surface level El. 7406).

3) Geotech

- Develop the subsurface soil (and rock) profiles and properties used for design
- Establish procedures and processes for identification and acceptance of suitable foundation rock
- Provide recommendations for excavating overburden and grouting
- If applicable, provide recommendations for handling shear zones
- Develop recommendations and criteria for foundation type and abutments*
- Determine hydraulic gradients under the dam
- Design the dam foundation and abutments
- Design rock fall mitigation

* Geotech and structural engineering coordination required to perform complete design

4) Structural

- Design the expansion of the existing dam to the desired elevation*
- Provide a comparison of different concrete technique/placement options
- Provide a concrete mix design, considering workability, temperature cracks, need for continuous placement
- Provide guidance to mitigate issues related to heat of hydration
- Provide a narrative regarding contraction joint layout and configuration

* Geotech and structural engineering coordination required to perform complete design

5) Construction

- Detailed cost estimate (design and construction)
 - Cost of Work shall include all work designed by your team plus assumptions for site improvements and paving
 - Provide bid tabs showing units, quantities and unit prices
 - Value Engineering / Project Alternatives (options to reduce cost and/or schedule)
- Design and Construction Schedule
- Formwork design for typical lifts when raising the dam
- Anticipated concrete placement production rates and anticipated equipment
- Heavy equipment cycle analysis to/from the dam location, anticipated number of trucks per day
- Risk Analysis
- Erosion Control Plan
- Site Logistics
- Phasing Plans
- Recommended aggregate source with alternatives
- Haul routes
- Identify public access to reservoir, if possible, during construction
- List of applicable permits required

6) Electrical, Instrumentation & Control, Paving and other site improvements are beyond the scope of this project and are not required.

Applicable codes / references

- ACI for dams -
https://www.concrete.org/store/productdetail.aspx?ItemID=207511&Format=PROTECTED_PDF
- U.S. Corps of Engineers -
http://www.publications.usace.army.mil/Portals/76/Publications/EngineerManuals/EM_1110-2-2200.pdf

- Bureau of Reclamation Gravity Dams -
<https://www.usbr.gov/tsc/techreferences/mands/mands-pdfs/GravityDams.pdf>
- Bureau of Reclamation Design Standards, Spillways -
<https://www.usbr.gov/tsc/techreferences/designstandards-datacollectionguides/designstandards.html#status>
- Bureau of Reclamation Design of Small Dams
- Federal Energy Regulatory Commission Guidelines on Dams
- Associations – Association of State Dam Safety (ASDS), United States Society on Dams (USSD)

Note: Faculty will provide specific guidance for deliverables relating to their respective concentration area.

C. Specific Limitations/Issues to Consider:

- 1) A project budget \$370M, including environmental permitting, environmental mitigation, design and construction
- 2) Existing reservoir capacity cannot be reduced during construction
- 3) Construction shall not disrupt existing reservoir and outlet works operation
- 4) Hydroelectric plant must remain in operation during all phases of construction, other than coordinated short-interval outages
- 5) There are various communities along the reservoir or near haul routes. It is important to minimize the impact to local residents as much as possible.
- 6) Public access to the reservoir during construction is a priority, if possible
- 7) Functionality and cost are the main drivers, however, suggestions for schedule improvements will be considered
- 8) CVEN 4899 Design Development (DD) documents shall be complete by 4/27/23 when a design-build team is chosen
- 9) (Hypothetically) The winning team shall complete final Construction Documents (CD) from May, 2023, until December, 2023
- 10) Construction shall begin April, 2024 and must be complete by November, 2028
- 11) Although site development, haul routes, quarries, power, lighting, security and other site improvements are not included in your design (by others), include these activities in your construction schedule
- 12) Normal project work hours are from 7am to 3:30pm. The local noise ordinance requires all work to be performed 7am – 7pm, however, certain operations may receive an exemption.
- 13) Dust must be controlled at all times
- 14) All lanes of Highway 72 and Flagstaff Road must remain open during normal construction operations
- 15) Consider construction safety and feasibility during periods of spring flooding
- 16) Consider all overhead obstacles at the project site and haul routes

D. RFP Process:

- 1) The evaluation of proposing teams will be spread over multiple deliverables. Denver Water acknowledges that extensive design will be required from all proposing teams and only one firm will win the contract award. To compensate teams who are not chosen as the winning firm, a stipend will be provided in the form of a Qdoba dinner (including queso sauce) at the end of the semester.
- 2) To be considered for award, firms shall conform to the following requirements –
 - a. Attend a mandatory site visit on **1/24/23**
 - b. Attend all information sessions
 - c. **1/26/23** – Submit a letter of interest signed by the principal(s). This letter should introduce the proposed team, including all disciplines and the organization chart. A primary contact person (team lead) shall be identified. Provide a written description of qualifications, experience and relevant background information of your firm and key team members.
 - d. **2/9/23** – Submit a design and deliverable timeline outlining all required tasks and the responsible team member assigned to each task
 - e. **2/28/23** – Submit Conceptual Design documents, design narrative and calculations
 - f. **3/2/23** – Deliver a presentation outlining your conceptual solution
 - g. **4/6/23** – Submit Schematic Design (SD) documents, drawings, design narrative and calculations. This is often considered an in-progress review as you continue to design.
 - h. **4/27/23** – Submit Design Development (DD) documents, drawings, design narrative and calculations. This will be your final written deliverable as you hope to win the design-build contract.
 - i. **4/28/23** – Participate in the College Senior Capstone Expo at Indoor Practice Field (Event details TBD)
 - j. **5/2/23** – Deliver a presentation outlining your final solution
 - k. **5/4/23** – Winning firm will be announced
- 3) All written **deliverables shall be submitted by 3:30pm** on the date listed above, via Canvas.

E. Evaluation Criteria

- 1) Each written deliverable will be evaluated based on the firm's ability to clearly and concisely:
 - a. State the problem and constraints (5% weight)
 - b. Compare and make selections between design alternatives and consider life-cycle costs and sustainability (5% weight)
 - c. Consider multiple constraints (5% weight)
 - d. Correctly complete the design (50% weight)
 - e. Present information in a professional format (style) (10% weight)
 - f. Organize information (5% weight)
 - g. Utilize software (AutoCAD, Revit, Sketchup, BlueBeam, HEC-RAS, MS Word/Excel, etc.) appropriately to communicate a design solution (20% weight)

- 2) Each presentation will be evaluated based on the firm's ability to:
- Deliver high quality, professional, convincing content (50% weight)
 - Exhibit proper presentation mechanics (body position, eye contact, body movement, oral delivery; personal appearance) (20% weight)
 - Use visual aids effectively (20% weight)
 - Answer questions (10% weight)

- 3) The overall grade plan is as follows –

Deliverable	Points	Client Input
Letter of Interest and Org Chart	25	
Design Schedule with Team Responsibilities	25	
Conceptual Design	100	Pending Availability
General and Drawing 20 Points		
Geotech 20 Points		
Water 20 Points		
Structural 20 Points		
Construction 20 Points		
Conceptual Design Presentation	100	X
Schematic Design (SD) Documents	200	Pending Availability
General and Drawing 40 Points		
Geotech 40 Points		
Water 40 Points		
Structural 40 Points		
Construction 40 Points		
Design Development (DD) Documents	300	Pending Availability
General and Drawing 60 Points		
Geotech 60 Points		
Water 60 Points		
Structural 60 Points		
Construction 60 Points		
Final Presentation	200	X
Quiz and attendance	50	
Total Available Points	1000	

** The group chosen by the Client as the winning team shall receive an additional 100 points*

- 4) The final selection will be announced in two categories:
- "Client's Choice"** - The client will be able to review portions of each firm's deliverables, but not every detail. Realistically, the client will review and provide feedback during presentations only. The client will choose a winner at the end of the semester. The winning group will be announced at the final day of class and receive an additional 10% applied to their grade. The "Client's Choice" will be displayed on the CVEN Senior Design plaque in the 4th floor hallway.
 - "Overall Winner"** – Taking all deliverables into consideration (including the client's choice bonus), an overall winner will be announced. This group will be the firm that wins the contract award. The "Overall Winner" will be displayed on the CVEN Senior Design plaque in the 4th floor hallway. (Note that the client's choice isn't always the overall winner, even with a 10% bonus)
- 5) A peer evaluation will be administered at the end of the semester. Individual grades may be adjusted if level-of-effort within the group is unbalanced.

F. Format:

- All documents shall be submitted electronically as a PDF
- Each written deliverables shall contain two files -

- a. Report Narrative: Electronic submission formatted to 8.5"x11" if printed. It is strongly recommended that you use MS Word. The overall design solution shall be addressed, followed by each discipline. Material selections shall be included in each discipline's section. The body of the report shall contain only concise images, figures and tables. All lengthy, expanded data should be included in the appendix. Calculations shall be included in the appendix with the following format: MathCAD is recommended, but scanned handwritten calculations are acceptable if legible and professional. Show all steps in the solution with final results clearly indicated.
- b. Drawings: Electronic submissions formatted to 11"x17" if printed. Must include a title block, dimensions, symbols ("targets"), scale and legend. Applicable sheets may include plan, section, elevation and detail. AutoCAD or Revit is recommended for all drawings.
- 3) Groups shall use MS PowerPoint for all presentations. Prezi will not be accepted due to past failures of this program (blank screens, old content, nausea-producing transitions).
- 4) File Names: File names for each PDF document shall consist of your team number and name followed by what is contained in the file (report, drawings, presentation) and which submittal it is for (Conceptual Design, Schematic Design, Design Development). For example: "Team 2 Buff Builders – Report – Conceptual Design.pdf" and "Team 2 Buff Builders – Drawings – Conceptual Design.pdf" are appropriately named files. This will ensure Faculty and TA's can track and review your documents.
- 5) Scanning Documents: When scanning documents to be included in your submittal, be sure to manually input the sheet size on the scanner rather than allowing the scanner to select the sheet size automatically. This prevents obscure sheet sizes like 8.375"x 10.75" from being included in your documents and will reduce painful printing should a hardcopy be needed.

G. Support Documents:

- 1) 1951 As-Built Drawings
- 2) 1955 Final Construction Report
- 3) 1974 Outlet Works Report
- 4) 1977 Outlet Works Drawing
- 5) 1985 Report – Dam Raise Study Volume 1
- 6) 1985 Report – Dam Raise Study Volume 2 (including geotech investigation)
- 7) 2001 Auxiliary Outlet Works Drawing
- 8) 2013 Test Quarry Report
- 9) 2015 Test Quarry Alternatives
- 10) 2015 Quarry Report
- 11) 2016 Final Quarry Location Report
- 12) Various .DWG files

Documents will be saved to the Canvas course website

SUPPLEMENTAL MATERIALS

Civil and Architectural Engineering Laboratories

Lighting Lab



- The Lighting Lab supports lighting curricula through active learning, testing, and experimentation.
- The lab is equipped with a goniophotometer, an integrating sphere, and luminance and illuminance meters that students use to perform light measurements.
- Lighting demonstrations and a variety of lighting equipment such as LED lamps and lighting controls help cement theoretical knowledge while at the same time afford students the chance to exercise creativity and their engineering skills.

Larson Lab: air flow room, sensor room, heat retention research

- The Larson Building Systems Laboratory permits the study of entire HVAC systems in a controlled dynamic environment, providing repeatable test conditions that have been previously unavailable.
- The facility consists of two configurable roof-top commercial HVAC systems that can be used to test a wide range of operational strategies of HVAC systems and subsystems with sophisticated data acquisition and control systems.
- Activities in the lab include the dynamic interactions between building thermal response and HVAC systems controls, ventilation control for indoor air quality, HVAC system diagnostics, and interactions between multiple control functions of HVAC systems.
- The lab houses 2 full-sized test chambers that can be used to model a large variety of indoor environment conditions, like offices, data centers, and hospital operating rooms.
- Through the Larson Laboratory, our students have unique learning opportunities, positioning them for successful careers in HVACR. Internship opportunities with the lab are also available for students to further advance their knowledge and practical experience.



Living Materials Laboratory

- The Living Materials Laboratory (LML) focuses on creating new, sustainable building materials.
- Undergraduate and graduate student researchers in the LML create new materials using wood, cement, bacteria, and algae and study their engineering properties.
- Experimental capabilities of the lab include mechanical testing to measure load-bearing capacity, thermal conductivity analysis to measure insulation properties, thermogravimetric analysis to measure thermal stability, X-ray diffraction to characterize mineral phases, Fourier-transform infrared spectroscopy to analyze chemical bonding, and a variety of cement and concrete characterization instruments.
- Computational capabilities include life cycle assessment to measure the environmental impacts of building materials and whole buildings.

CIEST lab: Geotechnical, Seismic/Structural Testing, & Materials testing

- The Center for Infrastructure, Energy, and Space Testing (CIEST), is an experimental testing facility with geotechnical centrifuge, structural dynamics, and materials testing.
- The geotechnical facility houses three centrifuges, including a 400 g-ton centrifuge that is amongst the most powerful in the United States, that is, used for research, industry, and educational purposes related to the characterization of geotechnical engineering systems (e.g. dams, foundations, pipelines) and the fundamental mechanical, hydraulic, and thermal properties of soil.



hydraulic equipment capable of applying up to 1 million lb (4450 kN) and loading rates up to 100 in./sec (2.5m/sec).

- Our lab can conduct combined mechanical and environmental loadings (variations of temperature, pressure, humidity, and chemicals) to simulate actual service conditions of structures. Always hiring interested UG/Grad research assistants. Check us out at: www.colorado.edu/center/ciest/



Construction Safety Research Alliance (CSRA)

- The Construction Safety Research Alliance (CSRA) is a unique community of industry practitioners and academic researchers who collaborate to create and share new knowledge about construction worker safety.
- The Mission of CSRA is to eliminate serious incidents and fatalities in the construction industry with transformative research and defendable science.
- The CU team includes an Executive Director (professor), Assistant Research Professor, Senior Research Associate, an Operations Manager, and over a dozen funded students
- The CSRA has over 300 active industry partners who represent all major sectors of the North American Construction Industry
- Our research is co-created with our industry partners; over 80 firms from across the US and Canada including Kiewit, CAT and Skanska.
- We publish and present our work on a global stage and host an annual CSRA Safety Summit at CU which in 2022 hosted 200+ safety professionals on campus, and broadcasted to a further 300+ across the world.
- Find out more here: [Home | Construction Safety Research Alliance \(colorado.edu\)](http://Home | Construction Safety Research Alliance (colorado.edu))

Student Involvement in CEAE



Kiewit Design-Build Scholars Program

- The Kiewit Design Build Scholars Program is a corporate funded opportunity for any full-time engineering student who is interested in infrastructure design and construction.
- The program has four main pillars – financial aid, a mentorship program, site tours and events, and opportunities for internship. We are in the third year of the program and typically have around 40 students in the cohort each academic year.
- Kiewit hopes to guide more students to choose heavy-civil and infrastructure design as a career path and support them holistically through their academic experience.



Student Societies:

Architectural Engineering Institute (AEI)

The AEI Chapter is a student organization dedicated to understanding and advancing the state-of-the-art of the architecture, engineering, and construction (AEC) profession through networking, design competitions, & learning experiences in the AEC community.



Associated General Contractors (AGC)

We strive to promote the construction industry in three areas which include education, service, and networking, and we have construction professionals speak at every weekly meeting to present on a specific project or on their company.



American Society of Civil Engineers (ASCE)

Our chapter coordinates with industry members to learn about opportunities within Civil Engineering, and compete in the Concrete Canoe, Innovation, Sustainability, Surveying, and Steel Bridge competitions through the ASCE Rocky Mountain Regional Symposium.

American Society of Heating, Refrigeration and Air Conditioning Engineers

Our chapter coordinates events, including industry expert talks/presentations, innovative academic research talks, technical workshops, site visits, and social events, helping you to network with industry professionals, stay up to date with research and industry best practices, and offer hands-on experience with HVAC equipment.

Bridge Buffs

Bridge Buffs is the CU Chapter of a national NGO called Engineers in Action, a non-profit organization that designs and builds pedestrian footbridges, and is dedicated to reducing poverty created by rural isolation by building pedestrian bridges over impassable rivers in communities that would otherwise be unable to afford them.



Engineers Without Borders (EWB)

EWB's mission is to partner with developing communities to improve quality of life through environmentally sustainable, equitable, and economical engineering projects. Our chapter was the first chapter of EWB-USA.



Illuminating Engineering Society

The CU IES Chapter is a community committed to inspiring those interested in lighting by providing tools for career success and building a shared knowledge base, while promoting engagement with industry professionals and each other.



Interested in learning more? Contact the CEAE office at: ceae@colorado.edu

For scholarship information: CU Boulder has automatic consideration for some scholarships, and an application for others, including Engineering scholarships: www.colorado.edu/finaid

Departmental career fairs are held in both the fall and spring.

The following companies have hired our undergraduate students:

Adolfson & Peterson Construction	Greystar	NewFields Mining Design &
AECOM	Group 14 Engineering	Technical Services
AEI Affiliated Engineers, Inc.	Hathaway Dinwiddie	Opus Holding, L.L.C.
Air Force Civilian Service	Hayward Baker	Otak, Inc.
Alfred Benesch & Company	Henderson Engineers, Inc.	Parsons
Ames Construction Inc	Hensel Phelps	PCL
Apex Engineers, Inc.	Holder Construction Company	PG Arnold Construction
Arcadis	Holland Partner Group	Pinkard Construction Co.
ARCO/MURRAY Natl. Construction	Howell Construction	Rick Engineering Company
Company	HPM, Inc.	Rider Levett Bucknall
Barnard Construction	Hyder Construction	RJH Consultants, Inc.
Big-D Construction	J.R. Butler, Inc.	The Weitz Company
BranchPattern	Jacobs	Turner Construction Company
Brinkmann Constructors	JE Dunn Construction	Vertex Builders, Inc.
Bureau of Reclamation	JVA, Inc.	W.E. O'Neil Construction Co.
CannonDesign	Keller North America, Inc.	Waner Construction Co., Inc
Cator Ruma & Associates	Kiewit	Whiting-Turner Contracting Co
City and County of Denver	KL&A	Wright Water Engineers, Inc
Colorado DOT	Kraemer North America LLC	WSP
Condon-Johnson and Assoc.	Manhard Consulting	Fisher Marantz Store
Confluence Builders, LLC	Martin/Martin Consulting	The Lighting Agency
CU Facilities Management	Engineers	RockSol Consulting Group, Inc.
EXP	Mazzetti	Ryan Companies US, Inc.
FCI Constructors, Inc.	MB BIM Solutions	S. A. Miro, Inc.
Flatiron Construction	McKinstry	Saunders Construction, Inc.
Fransen Pittman	ME Engineers	Shaw Construction LLC
Galloway & Company	MEP Engineering, Inc.	Shimmick Construction/AECOM
Garney Construction	Merrick & Company	Civil Construction
GBA, Inc.	Milender White	Shrewsbury & Associates, LLC
GEI Consultants, Inc.	Mortenson Construction	Simpson Gumpertz & Heger
GH Phipps Construction Cos.	MTech Mechanical	Skanska USA, Inc.
AE Design	NREL	Southland Industries
Horton Lees Brogden Lighting	BEGA North America	Stantec
Design	Lighting Design Alliance	Swinerton Builders
Visual Interest	SmithGroup	The RMH Group Incy

SUBMISSION ATTESTING TO COMPLIANCE