# Academic Program Review
# M MS Civil Engineering

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**APRC Recommendation to Faculty Senate**
**MS Civil Engineering**

The Academic Program Review Committee (APRC) affirms that the Department of Civil Engineering has completed program review as per policy, including self-study, external review, internal review, and action plan submission for the MS Civil Engineering. APRC recommends that the next program review be scheduled for six years from Faculty Senate approval; or, should the College of Engineering and Computer Science decide to schedule a college-wide program review, the next program review will occur at that time.

APRC Chair: Jeffrey Brodd, Professor of Humanities and Religious Studies

# MS IN CIVIL ENGINEERING (GRADUATE PROGRAM) SELF STUDY REPORT

**Department of Civil Engineering**
**College of Engineering and Computer Science**
**California State University, Sacramento**

December 29, 2022

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**Date: 12/29/2022**

**Date of Last Review: Self Study Completed – Spring 2010; External Review Completed – 2011**

**Department: Civil Engineering**

## BACKGROUND INFORMATION

### Contact Information

As of February 2021, Dr. Ghazan Khan is the department chair for the Department of Civil Engineering. The outgoing chair of the Department of Civil Engineering (CE) was Dr. Benjamin Fell who now serves as an Interim Associate Dean with the College of Continuing Education at California State University, Sacramento. Dr. Ghazan Khan along with Dr. Cristina Poindexter, the Graduate Coordinator in the Department, have had the primary responsibility for preparation of the self-study and are thus the primary contact persons for the Civil Engineering program.

| Department Chair | Graduate Coordinator |
|---|---|
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### University, College, and Department Missions

Sacramento State University Mission Statement: "As California's Capital University, we transform lives by preparing students for leadership, service and success. Sacramento State will be a recognized leader in education, innovation and engagement."

College of Engineering and Computer Science (ECS) Mission Statement: "Through contemporary curricula, engaging pedagogy, scholarship and applied research, we produce career-ready graduates prepared for a lifetime of professional achievement and intellectual growth."

Department of Civil Engineering Mission Statement: "Provide an outstanding, practice-oriented education in civil engineering and an advanced problem-solving resource for government and industry."

### Overview of Graduate Program in Civil Engineering

Civil Engineering encompasses a broad range of professional activities. The four years of undergraduate preparation for the Bachelor of Science degree are devoted to fundamental analytical principles and basic design applications. For technical competence in specialized areas and continued effectiveness on the job, graduate education is becoming increasingly necessary. In 2007, the American Society of Civil

Engineers (ASCE) adopted a Policy Statement (PS) 465 in which the master's degree in Civil Engineering is established as the minimum requirement for the entry to the profession of Civil Engineering (ASCE, 2008). ASCE established a 15-year implementation plan for the policy i.e., once the states adopt the policy, then it becomes required for any Civil Engineering program to offer a master's degree so that its graduates can qualify for the professional engineer (PE) license. Note that the PS 465 allows other pathways (through qualified experience) to reach licensure eligibility.

The Civil Engineering Department offers a graduate program of study leading to a Master of Science degree in Civil Engineering in the following areas of specialization:

- Environmental Engineering - analysis, design, and management of natural and engineered water systems including drinking water, wastewater, and stormwater; solid and hazardous waste management and regulations; air quality management and pollution control technologies;
- Geotechnical Engineering - properties and behavior of soil; seepage analysis with application to design of foundation, retaining structures, earth dams and slopes; soil improvement and ground stabilization; geosynthetics inclusions, soil dynamics, and earthquake engineering;
- Structural Engineering - advanced structural analysis methods; structural systems; advanced concrete and steel analysis and design applied to buildings and bridges; seismic analysis and design;
- Transportation Engineering - transportation engineering and planning, traffic flow theory, and system management applicable to all modes with emphasis on highway and multi modal transportation; interdisciplinary study with other areas of civil engineering as well as with non-engineering areas may also be arranged; and
- Water Resources Engineering - advanced hydraulics and hydrologic design and analysis of water systems, modeling of hydraulic and hydrologic water systems, hydrometeorology analysis, steady and non-steady analysis of groundwater movement of confined and unconfined aquifers, modeling of groundwater movement, and planning, management, and operation of water resource systems.

The MS in Civil Engineering consists of a choice of courses within a specialization, a choice of elective courses, a writing intensive course, a mathematics or statistics course, and culminating requirements; all selected by the student and approved by an advisor. Details of the required and elective courses are presented in Table 1 and Table 2.

## Table 1 Overview of the Requirements in Each Area of Specialization in the Graduate Civil Engineering Program

| Requirement | Environmental | Geotechnical | Structural | Transportation | Water Resources |
|---|---|---|---|---|---|
| **Writing (3 units, one course)** | CE 200 – Civil Engineering Professional Writing | CE 200 – Civil Engineering Professional Writing | CE 200 – Civil Engineering Professional Writing | CE 200 – Civil Engineering Professional Writing | CE 200 – Civil Engineering Professional Writing |
| **Mathematics/Statistics (3 units, one course); Recommended course is indicated with an asterisk (*)** | ENGR 201 – Engineering Analysis I<br>ENGR 203 – Engineering Analysis II<br>ENGR 203* – Engineering Statistics | ENGR 201<br>ENGR 202<br>ENGR 203* | ENGR 201*<br>ENGR 202*<br>ENGR 203 | ENGR 201<br>ENGR 202<br>ENGR 203* | ENGR 201<br>ENGR 202<br>ENGR 203* |
| **Core Courses (15 units)** | CE 232 – Groundwater Hydrology<br>CE 251 – Environmental Quality Processes I<br>CE 252 – Environmental Quality Processes II<br>CE 253 – Environmental Quality Processes II<br>CE 254 – Water Quality Management<br>CE 255 – Transport of Chemicals in Soil System<br>CE 250 – Systems Analysis of Resources Development | CE 270 – Advanced Soil Mechanics and Foundation I<br>CE 271 – Advanced Soil Mechanics and Foundation II<br>CE 272 Geotechnical Modeling<br>CE 273 – Ground Modification<br>CE 274 – Soil Dynamics and Earthquake Engineering<br>CE 275 – Geosynthetics | CE 260 – Matrix Structural Analysis<br>CE 261 – Finite Element Analysis<br>CE 262 – Nonlinear Structural Analysis<br>CE 263 – Advanced Steel Design<br>CE 264 – Advanced Design in Reinforced Concrete<br>CE 266 – Dynamics and Earthquake Response of Structures<br>CE 267 – Structural Systems of Buildings<br>CE 268 – Pre-stressed Concrete Bridge Design | CE 241 – Analysis and Control of Traffic Systems<br>CE 242 – Transportation Planning<br>CE 243 – Traffic Flow Theory<br>CE 244 – Advanced Transportation Facility Design<br>CE 245 – Pavement Design<br>CE 275 – Geosynthetics | CE 230 – Water Resources Planning<br>CE 231 – Hydrometeorology<br>CE 232 – Groundwater Hydrology<br>CE 234 – Advanced Engineering Hydraulics<br>CE 235 – Hydrologic Modeling<br>CE 281 – Systems Analysis of Resources Development |
| **Elective Courses [1] (3 – 6 units) (Refer to** Table 2 **for additional senior elective courses)** | Students typically take classes in Water Resources Engineering or senior elective courses. | Students typically take courses in structural engineering; geology, CE156 – Geo-Environmental Engineering, or CE 232 as part of their elective courses. | Students typically take Senior elective courses to augment the courses listed above. In some cases, students may take geotechnical courses | Students typically take courses in Urban Land Development graduate program, Geography Department GIS courses, or senior elective courses | Courses in Environmental Engineering; senior electives courses are available for students to take. |
| **Culminating Requirement (3 – 6 units)** | CE500 | CE500 | CE500 | CE500 | CE500 |

[1] The Department offers CE289 – Project Management as an elective course that all graduate students can take.

**Table 2 Senior Elective Courses Available for Graduate Students (organized by area of specialization)***

| Course Number | Course Title | Area |
|---|---|---|
| CE 133 | Design of Urban Water and Sewer Systems | Environmental/Water |
| CE 153 | Design of Water Quality Control Process | Environmental |
| CE 156 | Geoenvironmental Engineering | Environmental |
| CE 171 | Soil Mechanics and Foundation Engineering | Geotechnical |
| CE 175 | Geotechnical Earthquake Engineering | Geotechnical |
| CE 163 | Structural Design in Steel | Structural |
| CE 164 | Reinforced Concrete Design | Structural |
| CE 165 | Masonry Design | Structural |
| CE 166 | Seismic Behavior of Structures | Structural |
| CE 168 | Pre-stressed Concrete Design | Structural |
| CE 169 | Timber Design | Structural |
| CE 141 | Traffic Analysis and Design | Transportation |
| CE 142 | Transportation Systems | Transportation |
| CE 144 | Geometric Design of Highways | Transportation |
| CE 131 | Hydrology | Water Resources |
| CE 132 | Groundwater Engineering | Water Resources |
| CE 134 | Open Channel Hydraulics | Water Resources |
| CE 182 | Introduction to GIS in Civil Engineering | All Areas |

*Students may take up to 6 units of 100 level elective courses for the graduate program provided that they did not take them as part of their undergraduate degree.

Admission Requirements

Admission as a classified graduate student in Civil Engineering requires:

- an undergraduate degree in Civil Engineering; and
- a minimum 2.8 GPA.

In addition, the merit of past academic endeavor and/or professional experience, potential for future study, and professional goals may also be considered for granting admission through submission of the civil engineering department supplemental application form.

Applicants who have deficiencies in admission requirements that can be removed by specified additional preparation may be admitted with conditionally classified graduate status.

Students with a baccalaureate degree in engineering majors other than Civil Engineering (e.g., Electrical and Electronic, Industrial, Mechanical, or Surveying) or in other non-engineering scientific disciplines (e.g., Mathematics, Physics, or Geology) who wish to pursue the graduate program in Civil Engineering may be considered on an individual basis. Such students may be admitted as conditionally classified students and will be required to complete a specifically designed list of undergraduate prerequisite courses in engineering and/or mathematics, physics, and chemistry to correct undergraduate deficiencies. Such a student must have an approved study program on file with the Department while undertaking this qualifying work. Upon completion of these courses with a GPA of 2.8 or better, the student may apply for classified graduate status in Civil Engineering.

Minimum Units and Grade Requirements for the Degree

Total units Required for the MS: 30; includes research or independent study and units required in specializations (see Program Requirements below)

Minimum Cumulative GPA: 3.0. No course in the program of study may have a grade below "C+".

Advancement to Candidacy

Each student must file an application for Advancement to Candidacy, indicating a proposed program of graduate study. This procedure should begin as soon as the graduate student has:

- removed any deficiencies in admission requirements;
- obtained classified graduate status;
- completed at least 12 units in the graduate program with a minimum 3.0 GPA, including at least three courses at the 200-level;
- taken the Graduate Writing Intensive (GWI) course in the degree program within the first two semesters of coursework at California State University, Sacramento; and
- selected and obtained approval for a culminating requirement (Plan A, B, or C).

Link to University Catalog: https://catalog.csus.edu/colleges/engineering-computer-science/engineering-civil/ms-in-civil-engineering/

**Program Delivery Mode**

The Graduate Program in Civil Engineering program is offered on the Sacramento State campus to full-time and part-time graduate students as a weekday program only. All graduate courses are offered either early morning or early/late evening given a majority of the graduate students are also working professionals. All courses are delivered in person, except for the necessary distance learning during the recent past because of the COVID-19 pandemic. Some courses have supplemental instruction online, but there are no dedicated on-line courses in the program.

Internship opportunities are available and allow students to gain professional experience as part of their educational program. Participation in an internship is encouraged but not required, and participation does not satisfy any academic requirements.

**Major Structural Changes**

Discontinuation of Engineering Management Emphasis Option

Prior to 2019, Graduate students were given the option to elect an emphasis in Engineering Management by taking elective courses in the College of Business Administration. Graduate students interested in this option could select up to 9 units of foundation courses and/or graduate business classes in consultation with the faculty advisor. This option was dropped for a couple of reasons. First, graduate students in civil engineering were having difficulties finding space in courses offered by the college of business. Second, it was difficult to articulate a set of courses that students could select

within 9 units that could provide a meaningful understanding and emphasis of Engineering Management, e.g., taking an introductory accounting course would count towards the Engineering Management option, however, it hardly provided any wholistic view or understanding of Engineering Management. Therefore, the Department decided to discontinue this option and instead allow students to develop their breadth in the Civil Engineering field through elective courses within the Civil Engineering Department or complimentary courses from other departments.

Discontinuation of Certificate Programs

Prior to 2019, as part of the Graduate Program in Civil Engineering, the Department offered ten different graduate certificates in specialized areas using a combination of courses as presented in Table 1. The students enrolled in a Certificate Program were required to be admitted as graduate students and were required to take a set of four specific graduate courses as part of each of the ten Certificate Programs on offer. The Certificate Program was started to meet the needs of practicing professionals to improve their advanced skills by taking advanced courses and not necessarily a complete master's degree. Agencies such as Army Corps of Engineers in Sacramento were instrumental in the development of the certificate program. However, the demand for the Certificate Programs had dried up and there were no certificates awarded in the period between 2014 – 2019. Therefore, the Department made the decision to discontinue the Graduate Certificate Program.

New GWAR Writing Course Requirement

Given the decision by the university to discontinue the different options for graduate students to satisfy Graduate Writing Assessment Requirements (GWAR), the Department of Civil Engineering embarked upon developing a new writing course specifically for graduate students named CE 200: Civil Engineering Professional Writing. This is a required course in the graduate program and resulted in reduction of the number of elective units from 6-9 units to 3-6 units (numbers vary given the number of units selected by students for Culminating Experience, 3 – 6 units).

New Student Learning Outcomes

The Department of Civil Engineering developed seven new Student Learning Outcomes in view of the Program Learning Outcomes and the University Graduate Learning Goals to help with the assessment activities in the graduate courses. These student learning outcomes are described in detail in the subsequent sections and greatly enhanced the assessment process.

## LEARNING OUTCOMES AND ASSESSMENT

### Program Learning Outcomes

The program learning outcomes or program educational objectives are a set of outcomes that the Department expects our graduates to achieve after completing the graduate program. That is, upon graduation, the students in the graduate program will be able to:

a) Succeed in professional employment at their chosen specialty of environmental, geotechnical, structural, transportation, or water resources engineering.
b) Identify, analyze, and solve complex practical civil engineering problems in their chosen field of specialty.
c) Communicate effectively about technically complex engineering problems to peers, other professionals, decision makers, and the general public, in the conduct of their work.

These educational objectives were developed to assess the success of the program. They are consistent with the mission of our program, which targets practicing professional engineers in the community as well as students just beginning their civil engineering careers or transitioning into civil engineering careers from related fields. These educational objectives are patterned after the educational objectives for the undergraduate program that were developed for ABET accreditation. While some students graduating from our undergraduate BS in Civil Engineering Program pursue careers in construction or general civil engineering practice, most students graduating from the BS program start working in one of five mains areas of civil engineering (geotechnical, environmental, structural, transportation, and water resources). These BS graduates in particular often choose to pursue a graduate degree and find it beneficial for their success in the field. The graduate degree program offers all students an opportunity to improve their engineering skills to tackle more complex and specialized problems. It also offers instruction and experience in engineering communication. Civil Engineering MS Program Learning Outcome (PLO) 1 targets post-graduation career success specifically. PLO 2 targets problem solving within students' chosen area of specialization. PLO 3 targets effective communication since civil engineers deal with the general public, decision makers, and other engineers and effective communication is important to being considered a competent engineer.

### Assessment Process and Details

The Department of Civil Engineering continues to undertake several assessment activities as part of the overall assessment process in the graduate program, details of which are presented in this section. The assessment process has been impacted by the onset of the COVID-19 pandemic given the various challenges in trying to maintain delivery of instruction in an online environment. Nevertheless, the assessment process was reinvigorated by the establishment of the first assessment committee in the Department in Fall 2021 semester. The Department has developed a five-year plan for assessment (presented in later section). Some assessment tools are developed and already utilized while additional sources of data and tools are under consideration and in development. The Department is planning to use direct and indirect measure, graduating student survey, and alumni survey for its assessment (similar to its well-established assessment as part of ABET accreditation). One of the challenges that the Department faces in the assessment of the graduate program is the relatively smaller sample that can

be obtained in the assessment. Accordingly, the Department is planning to accumulate the data for multiple-year assessment to be able to make any firm conclusions. This is an area that the Department will investigate as it collects the assessment data.

The Department of Civil Engineering master's degree Program Learning Outcomes (PLO) support the achievement of the Institutional Graduate Learning Goals for master's degrees. In the past, the master's degree PLO were assessed directly through assessment activities. In 2017, the Department developed seven Student Learning Outcomes (SLO) in view of the Institutional Graduate Learning Goals for master's degree. The relationship between the SLO (in line with the Institutional Graduate Learning Goals) and the master's degree PLO is presented in Table 3. Table 3 is useful to illustrate how the SLO work together to meet the broader program learning objectives for the benefit of the graduate students. The master's degree SLO are further described specific to the MS in Civil Engineering Program as shown in Table 4. Table 4 also shows the methods by which the data is planned to be monitored for each SLO and details of where the data may be collected.

The SLO are also shown in Table 5 as they relate to each graduate course in the curriculum detailing which SLO are covered by each course in the different specializations offered in the MS program. Developed and updated by the faculty Table 5 provides some insight into the depth and breadth of the program outcomes by each graduate course in the curriculum. Faculty members teaching the courses in the curriculum review their courses to assess the contribution of each course to the SLO and correlate course objectives with learning outcomes.

**Table 3 CE MS Program – Relationship between Institutional Graduate Learning Goals for Masters Programs and Program Learning Outcomes**

| | | Program Learning Outcomes (PLO) | | |
|---|---|---|---|---|
| | | PLO 1. Succeed in professional employment at their chosen specialty of environmental, geotechnical, structural, transportation, or water resources engineering | PLO 2. Identify, analyze, and solve complex practical civil engineering problems in their chosen field of specialty | PLO 3. Communicate effectively about technically complex engineering problems to peers, other professionals, decision makers, and the general public, in the conduct of their work |
| Institutional Graduate Learning Goals | Disciplinary Knowledge | X | X | |
| | Communication | | | X |
| | Critical Thinking/ Analysis | | X | |
| | Information Literacy | | X | |
| | Professionalism | X | | X |
| | Intercultural/ Global Perspectives | X | X | X |
| | Research | X | X | X |

### Table 4 Summary of Assessment Data and Action Plan for Student Learning Outcomes

| Institutional Graduate Learning Goal | Student Learning Outcome (SLO) | Assessment Plan Lines of Evidence | | | Data Source/Action Plan |
|---|---|---|---|---|---|
| | | Direct | Indirect | Evaluation Parameter | |
| Disciplinary Knowledge | SLO1: Succeed in professional employment at their chosen specialty of environmental, geotechnical, structural, transportation, or water resources engineering. | | X | Percentage of survey respondents' answers to various survey questions | Survey of MS Program Alumni |
| Communication | SLO2: Communicate effectively about technically complex engineering problems. | X | X | Scores from evaluation rubrics; Percentage of survey respondents' answers to various survey questions | CE 500 Culminating requirement presentation rubric submitted by faculty attending presentations |
| Critical Thinking / Analysis | SLO3: Identify, analyze, and solve complex practical civil engineering problems in a selected field of study in civil engineering. | X | | Scores from evaluation rubrics | Collect direct measures from exams and assignments in courses from each specialization area (details provided in subsequent sections) |
| Information Literacy | SLO4: Access, evaluate, and integrate information effectively and efficiently into original work. | X | | Scores from evaluation rubrics | CE 200 Graduate Writing Course Assignment |
| Professionalism | SLO5: Build and sustain professional relationships and networks | | X | Survey respondents' answers to various survey questions | Survey of MS Program Alumni |
| Intercultural / Global Perspectives | SLO6: Understand the impact of engineering solutions in a broader global, economic, environmental, and societal context | X | | Scores from evaluation rubrics | CE 200 Graduate Writing Course Assignment |
| Research | SLO 7: Conduct independent research or study resulting in an in-depth evaluation and understanding of a specific problem statement or focused topic | X | | | CE 500 Culminating requirement presentation rubric submitted by faculty attending presentations |

## Table 5 MS in Civil Engineering Curriculum Map

| Curriculum Map | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Coursework** | **SLO 1** | **SLO 2** | **SLO 3** | **SLO 4** | **SLO 5** | **SLO 6** | **SLO 7** |
| **Environmental** | | | | | | | |
| ENGR 203 | X | | X | | | | |
| CE 200 | | X | | X | X | X | |
| CE 251 | X | X | X | X | X | | |
| CE 252 | X | X | X | X | X | | |
| CE 253 | X | X | X | X | X | | |
| CE 254 | X | X | X | X | X | | |
| CE 255 | X | | X | | | | |
| CE 281 | X | X | X | X | X | | |
| CE 500 | X | X | X | X | X | X | X |
| **Geotechnical** | | | | | | | |
| ENGR 203 | X | | X | | | | |
| CE 200 | | X | | X | X | X | |
| CE 270 | X | X | X | X | X | | |
| CE 271 | X | X | X | X | X | | |
| CE 272 | X | | X | X | | | |
| CE 273 | X | X | X | X | X | | |
| CE 274 | X | X | X | | | X | |
| CE 275 | X | X | X | X | X | | |
| CE 277 | X | X | X | X | X | | |
| CE 500 | | X | X | X | X | X | X |
| **Structures** | | | | | | | |
| ENGR 201 | X | | X | | | | |
| ENGR 202 | X | | X | | | | |
| CE 200 | | X | | X | X | X | |
| CE 260 | X | X | X | | | | |
| CE 261 | X | X | X | | | | |
| CE 262 | X | X | X | | | | |
| CE 263 | X | X | X | X | | X | |
| CE 264 | X | X | X | X | X | X | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CE 266 | X | X | X | | | | |
| CE 267 | X | X | X | X | | X | |
| CE 268 | X | X | X | X | X | X | |
| CE 500 | X | X | X | X | X | X | X |
| **Transportation** | | | | | | | |
| ENGR 203 | X | | X | | | | |
| CE 200 | | X | | X | X | X | |
| CE 241 | X | X | X | X | X | | |
| CE 242 | X | X | X | X | X | X | |
| CE 243 | X | | X | X | X | | |
| CE 244 | X | | X | X | X | X | |
| CE 245 | X | | X | X | X | | |
| CE 275 | X | X | X | X | X | | |
| CE 500 | X | X | X | X | X | X | X |
| **Water Resources** | | | | | | | |
| ENGR 203 | X | | X | | | | |
| CE 200 | | X | | X | X | X | |
| CE 230 | X | X | X | X | X | X | |
| CE 231 | X | X | X | X | | | |
| CE 232 | X | X | X | X | | | |
| CE 234 | X | X | X | X | | | |
| CE 235 | X | X | X | X | X | | |
| CE 281 | X | X | X | X | X | X | |
| CE 500 | X | X | X | X | X | X | X |

**Assessment of Student Learning Outcomes**

The Department utilizes a wide range of both course- and program-level data to evaluate the graduate program continuously and make modifications where necessary. Course-level data are evaluated by individual faculty and include assessment of student achievement of course objectives (grading) and evaluation of student success in meeting the SLO. Altogether, individual faculty members, and the Department as a whole, use this information to make modifications and improvements to the curriculum. Program level data include: graduating students surveys (in development), alumni survey, discussions with advisory committees, and evaluations of CE 500 (Culminating Experience) presentations. Table 4 provides details of some of the sources of data used in the assessment.

During the current review period, the Department of Civil Engineering faculty have developed and utilized various data sources and rubrics for all seven SLOs. The Department assessment committee worked collectively, first revising and developing the tools and rubrics and later collaborating with other faculty to collect appropriate data. A summary of assessment activities and results for each SLO are presented in the following sections.

<u>SLO 1: Succeed in professional employment at their chosen specialty of environmental, geotechnical, structural, transportation, or water resources engineering.</u>

SLO 1 was assessed through an indirect measure. The Department has developed survey questions for alumni of the graduate program. Initially, the survey had 12 questions. This survey was significantly revised recently and expanded to 22 questions in order to capture new and relevant data to the graduate program. A copy of the complete survey can be found in Appendix A.

The survey was most recently conducted in fall 2022 and is intended to be conducted annually in the future. The survey is distributed to alumni of the graduate program (who have chosen to share their contact information with the department).

The survey includes a set of questions that collect information about alumni attainment of the Professional Engineering (P.E.) license. The P.E. license is required in many civil engineering jobs, is important for growth and success, and can serve as a measure of how successful professionals are or can potentially be in their respective positions. The graduate program in civil engineering emphasizes attaining a P.E. license with students. Additionally, a significant number of students join the graduate program in civil engineering because their bachelor's degree is not in civil engineering, hence they are not eligible to take a P.E. exam. Such students are either interested in the civil engineering field or working in a civil engineering job and can obtain a graduate degree in civil engineering to be eligible to sit the P.E. exam with fewer years of civil engineering experience. Thus, the data collected from these questions can provide a measure of how successful alumni have been in their positions by attaining a P.E. license. The Department expects that at least 75% of the graduates obtain and maintain a P.E. license. The specific questions on the survey are presented below:

- Do you have a P.E. License? (Yes/No response)
- How often do you use your P.E. Stamp? (Frequently, Occasionally, Rarely, Never)

The results of the survey responses to the abovementioned questions are presented in Figure 1. The results show that 85.7% of the students who graduated from the MS in Civil Engineering program possess a P.E. license and maintain it. A majority (more than 75%) of the respondents obtained their

P.E. license after completion of their master's degree. Figure 2 shows that almost 80% of the alumni continue to actively use their P.E. license in their work. These results show that alumni of the graduate program have continued to be successful in their professional jobs after graduation.

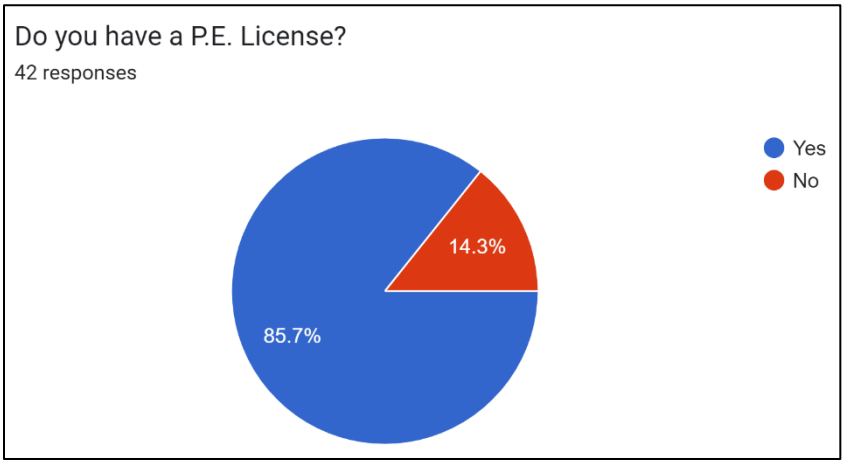



**Figure 1 Graduates of MS in Civil Engineering with a Professional Engineer (P.E.) License**

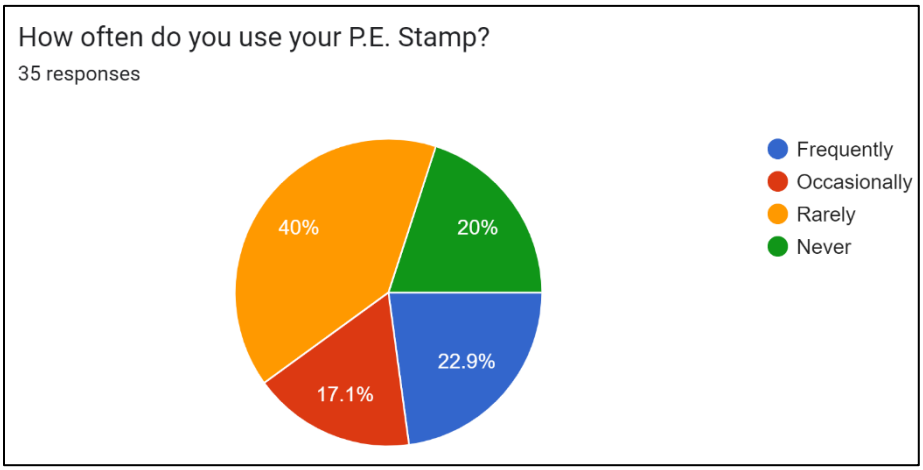



**Figure 2 Civil Engineering MS Alumni use of P.E. Licensure**

The survey included another question to assess how the graduate program in civil engineering helped alumni in their professional careers. The specific question asked of respondents was, "In what way did the master's degree help you? (Select all that applies)" with the following response options:

- Secure a raise or better salary
- Handle more complex projects and problems
- Achieve personal goal
- Get a promotion
- Get a new job offer

From the response data, 27 respondents (64.3%) selected the option “Handle more complex projects and problems” as shown in Figure 3. In other words, these respondents credited their master’s degree to their ability to handle more complex engineering projects and problems which would have led to success in their profession. Thus, obtaining a master’s degree allowed them to be successful in their professional careers. Other responses, such as “Secure a raise or better salary” can also be indicative of success in the profession as a direct result of the graduate degree in the view of the respondents. The Department is very satisfied with the percentage of respondents who indicated the MS in civil engineering helped prepare them to “Handle more complex projects and problems” showing the value of the MS in civil engineering degree.

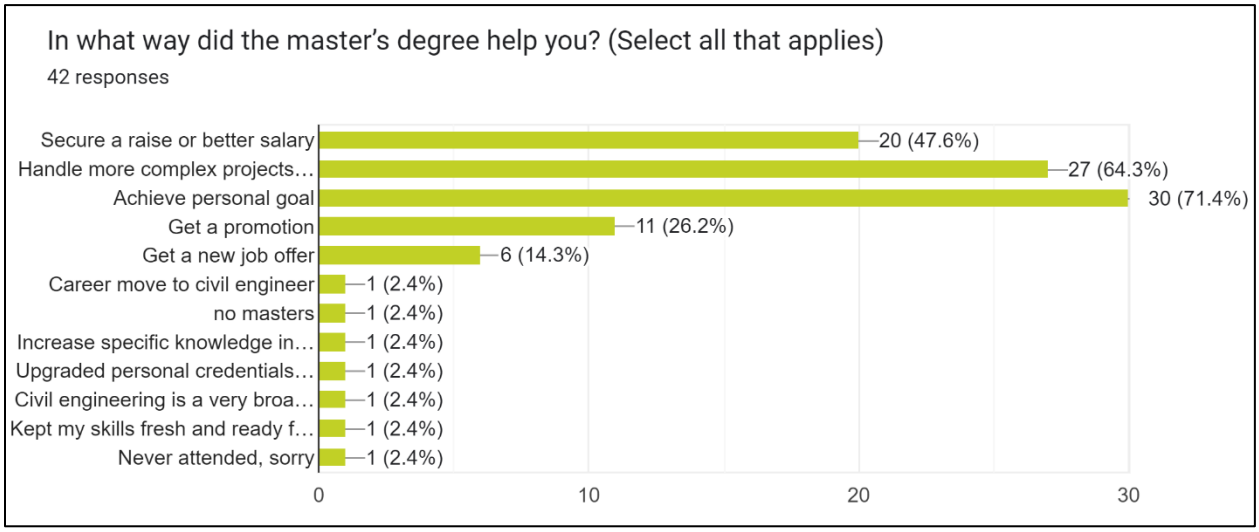



**Figure 3 MS in Civil Engineering Alumni Survey Response - Graduate Degree Value**

In view of the survey results, it is clear that the graduate program in civil engineering continues to be successful in SLO 1 allowing graduates to be successful in their chosen area of specialty. The Department views these results as satisfactory in achieving the goals of the graduate program.

SLO 2: Communicate effectively about technically complex engineering problems

SLO 2 was assessed through both direct and indirect measure of student performance. Direct measures were obtained using a prescribed rubric used in the evaluation process. Indirect measures were obtained through the survey of alumni as described in the previous section and presented in Appendix A.

Students in the graduate program are required to take the CE 500: Culminating Experience course (3-6 units) as a requirement of graduation. One requirement of the CE 500 course is that students present their culminating experience work to the faculty and students at the completion of their work. The Department has developed an evaluation form with a rubric to evaluate student presentations on a number of performance indicators. The rubric contains five performance indicators, each assessed at four levels of competency scored from 1 (lowest score) to 4 (highest score). A copy of the full rubric can be found in Appendix B. The evaluation forms are distributed before each presentation to faculty members attending the presentation and collected after the completion of the presentation. The

evaluation process is repeated for each student presenting that day and the average of the scores for each student for each performance indicator are averaged.

In order to evaluate SLO 2, the following performance indicators were utilized from the CE 500 evaluation rubric: "Devise an Organized Presentation", "Deliver Content Effectively", and "Develop Visual Materials that Effectively Support Oral Delivery". The performance of each student was based on their numeric scores from 1 to 4 on each of these performance indicators. The Department expects that at least 75% of the graduates obtain a score of 3 or above on these three performance indicators.

Table 6 shows the percentage of students obtaining a score of 3 out of 4 or higher for each of five semesters between Fall 2020 and Fall 2022 as well as over all five semesters. The total number of students evaluated each semester is also indicated in the table. Over all five semesters the number of students evaluated was 39. At least 75% of students earned a score of 3 or higher for the performance indicator "Devise an Organized Presentation" across all five semesters and at least 75% of students earned a score of 3 or higher for the performance indicator "Develop Visual Materials that Effectively Support Oral Delivery" in four out of five semesters. Students performed less well on the performance indicator "Deliver Content Effectively", with 69% achieving a 3 or higher score in this performance indicator over all semesters. However, the overall combined average of scores on all three performance indicators for students over all five semesters is 81%, which is above the mark of 75% set by the Department. The raw data used to prepare Table 6 is presented in Appendix B.

**Table 6 CE 500 Culminating Experience Percent of Students with 3 or Higher Score on Performance Indicators Related to SLO 2**

| Performance Indicator | Fall 20 (n = 6) | Spring 21 (n = 7) | Fall 21 (n = 6) | Spring 22 (n = 16) | Fall 22 (n = 4) | All Semesters (n = 39) |
|---|---|---|---|---|---|---|
| Devise an Organized Presentation | 83% | 100% | 83% | 88% | 100% | 92% |
| Deliver Content Effectively | 67% | 71% | 67% | 69% | 50% | 69% |
| Develop Visual Materials that Effectively Support Oral Delivery | 100% | 86% | 50% | 81% | 75% | 82% |
| **Average** | 83% | 86% | 67% | 79% | 75% | **81%** |

SLO 2 was also assessed using responses from the survey of alumni of the graduate program (shown in Appendix A), which included the following question:

- Please rate how much the Graduate Program helped you improve your Communication Skills (rating on scale of 1 – 5; 1 indication "not at all", 5 indicating "a great deal")

This question assessed the overall perception of the alumni in how it helped them improve their communication skills through the various activities in the graduate program, including presentations in course work, culminating experience presentation, and other opportunities for students to gain knowledge and skills that allow them to better communicate with stakeholders in their professional careers.

The results of the survey question responses are presented in Figure 4. The results show that a majority of the respondents feel that the graduate program in civil engineering helped improve their

communication skills. These results are an indication of the success of the graduate program towards SLO 2. The Department expects that with the introduction of the new required course, CE 200: Civil Engineering Professional Writing, MS graduates responding to future alumni surveys will report that Graduate Program helped improve their communication skills to an even greater extent.

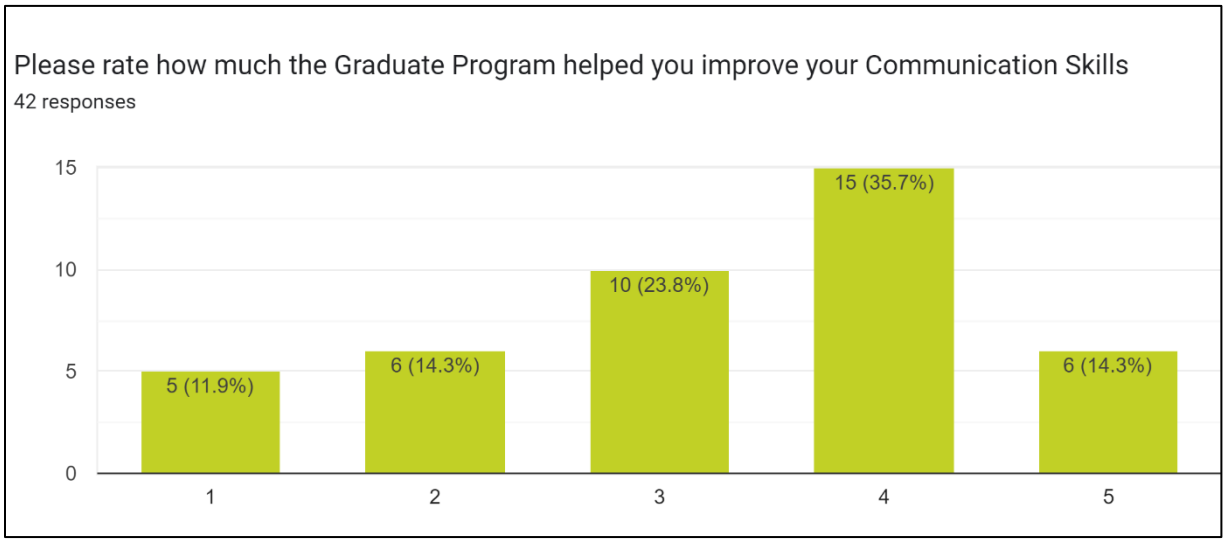



**Figure 4 MS in Civil Engineering Alumni Survey - Communication Skills**

SLO 3: Identify, analyze, and solve complex practical civil engineering problems in a selected field of study in civil engineering

SLO 3 was assessed using direct measures of student performance on assignments and exam questions in various courses in the graduate program. The department has developed a five-point scale rubric specifically for grading assignments, exam questions, or projects related to SLO 3, which is presented in Appendix C. The Department developed a criterion of achieving the learning outcomes of 75% of the students to be in the score category of 4 and 5. SLO 3 directly relates to civil engineering problems specific to the five areas of specializations in the graduate program, hence data were utilized from different courses; at least one course from each specialization (Environmental, Geotechnical, Structural, Transportation, Water Resources). Table 7 presents the list of courses in each specialization area from which data were collected and utilized to assess SLO 3.

**Table 7 List of Data Sources for Assessment of SLO 3**

| Course | Specialization | Semester | Number of Students | % Students Achieving Learning Outcome |
|---|---|---|---|---|
| CE 252/CE 253: Environmental Quality Processes II/III | Environmental | Spring 2020/Fall 2020 | 10 | 60% |
| CE 272: Geotechnical Modeling | Geotechnical | Spring 2016 | 5 | 60% |
| CE 261: Finite Element Analysis | Structural | Spring 2019 | 12 | 67% |
| CE 241: Analysis and Control of Traffic Systems | Transportation | Spring 2021 | 7 | 72% |
| CE 232: Groundwater Hydrology | Water Resources | Spring 2022 | 9 | 78% |
| **Overall Average** | | | | **67.4%** |

The assessment results of SLO 3 from courses within each specialization are presented in detail in the following sections.

*SLO 3 Results: Environmental*

SLO 3 was assessed through direct measure of student performance in the course CE 252 – Environmental Quality Processes II. CE 252 is a core class for students in the graduate program specializing in environmental engineering area. Data from the final exam of seven students enrolled in the course in the Spring 2020 semester were used in this assessment. The exam consists of conceptual and numerical questions and the students are asked to design a biological reactor or analyze an existing biological reactor based on the materials covered in the course. Students use problem solving and critical thinking skills to identify critical parameters in biological processes and design/analyze the system accordingly. A copy of the final exam can be found in the Appendix C.

Similarly, SLO 3 was also assessed direct measures of student performance on the final exam in the CE 253 - Environmental Quality Processes III (CE 253) courses, which focuses on physical/chemical processes in environmental engineering. Students learn the theories of various physical and chemical treatment processes and apply the knowledge to solve complex design/analysis problems. Data from the final exam of three students enrolled in the course in the Fall 2020 semester were used in this assessment. The exam consists of four numerical questions and the students are asked to design various treatment units based on the materials covered in the course. A copy of the final exam can be found in the Appendix C.

Using the rubric (Appendix C) developed by the Department, the combined assessment data for SLO 3 from both the abovementioned courses is presented in Table 8. Table 8 shows the rounded values of overall ratings using individual scores of each performance indicator in the rubric. Both the rubric and raw scores are presented in Appendix C.

Overall, 60% of the students were at least at the 4 or above rating on the rubric, which is below the expected 75% mark. In order to improve student performance in the future, more individual assignments will be assigned throughout the semester to better internalize the materials and prepare the students for the final exam. The results could be attributed to a small sample size as well, which is why the assessment committee will continue to monitor student performance in SLO 3 in the environmental engineering area in the future.

**Table 8 SLO 3 Assessment Rubric Data from CE 252 and CE 253 Courses in Spring and Fall 2020**

| Student | Exemplary (5) | Very Good (4) | Good (3) | Marginal (2) | Below Expectation (1) |
|---|---|---|---|---|---|
| Student 1 | | X | | | |
| Student 2 | X | | | | |
| Student 3 | X | | | | |
| Student 4 | | | | X | |
| Student 5 | | | X | | |
| Student 6 | | | X | | |
| Student 7 | | X | | | |
| Student 8 | X | | | | |
| Student 9 | X | | | | |
| Student 10 | | | X | | |

*SLO 3 Results: Geotechnical*

SLO 3 was assessed through direct measure of student performance in the course CE 272 – Geotechnical Modeling (previously called CE 280C). CE 272 is a core class for students in the graduate program specializing in geotechnical engineering area. Data from the term project of five students enrolled in the course in the Spring 2016 semester were used in this assessment. In this term project, students were asked to measure dynamic soil shaking response from a centrifuge test using numerical modeling. Students needed to identify the critical aspect of soil response to be captured as well as the necessary boundary conditions. Using the numerical software, FLAC 8, students then calculated the expected response during dynamic shaking and then compared the response to that observed. Differences in the response calculated and measured needed to be explained. A project report was submitted summarizing the numerical analysis work and the comparison to the measured response. A copy of the project can be found in the Appendix C.

The results of the assessment of the term project reports using the rubric developed by the Department as presented in Appendix C, are shown in Table 9. The results show that 60% of the students in the class are achieving the learning outcome (SLO 3) in the score category of 4 and 5, which is below the expected 75% mark. These results can be attributed to either the small sample size or particular cohort of students. Nevertheless, the assessment committee aims to work with the instructors in the geotechnical area to gather additional data and assess student performance periodically in the future to ensure attainment of SLO 3.

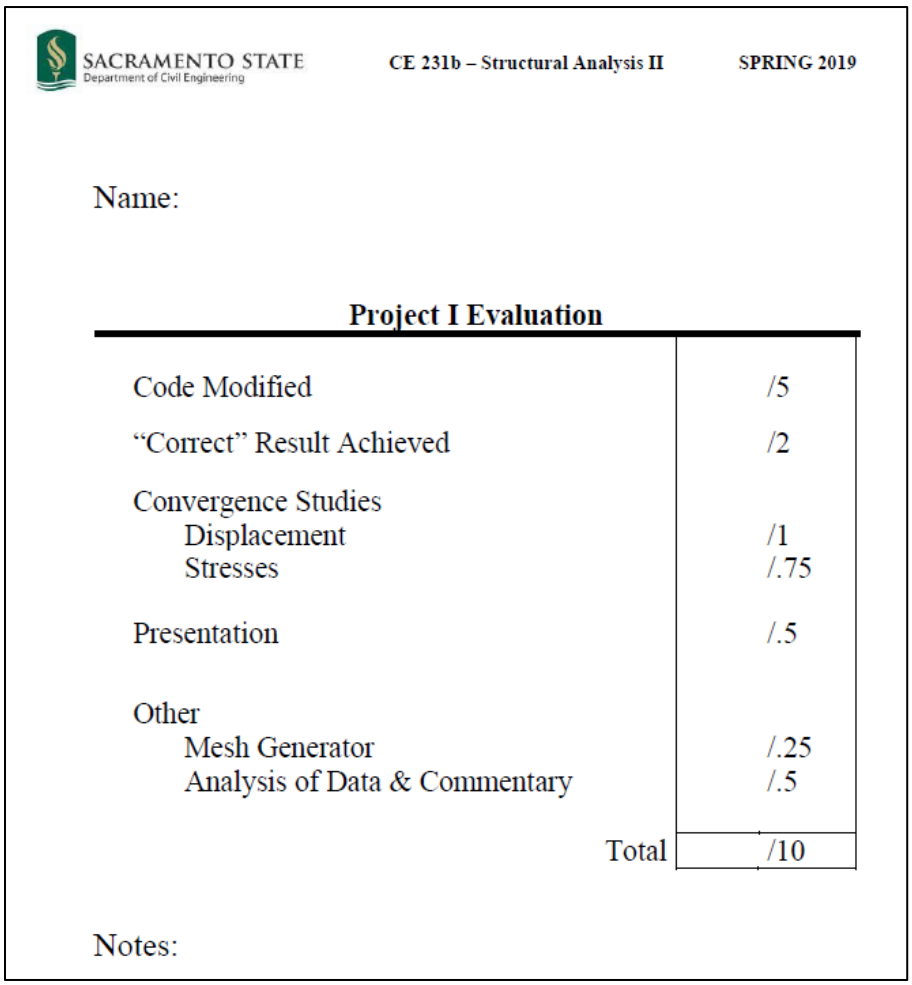
**Table 9 SLO 3 Assessment Rubric Data from CE 272 Course in Spring 2016**

| Student | Exemplary (5) | Very Good (4) | Good (3) | Marginal (2) | Below Expectation (1) |
|---|---|---|---|---|---|
| Student 1 | | X | | | |
| Student 2 | X | | | | |
| Student 3 | | | X | | |
| Student 4 | | | X | | |
| Student 5 | X | | | | |

*SLO 3 Results: Structural*

SLO 3 was assessed through direct measure of student performance in the course CE 261 – Finite Element Analysis (previously called CE 231B: Computer Methods of Structural Analysis II). CE 261 is a core class for students in the graduate program specializing in structural engineering area. Students in this class are required to complete a project in which they build upon an existing code in MATLAB to analyze more complex structural members using the finite element method. The initial code is written for the direct stiffness method and must be dramatically adapted to a more complex analysis method. The students are using their critical thinking skills to assess what the existing code does, modify that code, and present a solved problem of their choice to indicate the success of their adaptation. Their code modification process and findings are summarized in a project report. A copy of the project description can be found in Appendix C. The activities in this project are a typical example of a complex and practical civil engineering problem in the structural engineering field directly related to SLO 3.

The assessment data from this course was collected during the Spring 2019 semester for 12 students taking the class. The project was graded using a course specific rubric as shown in Figure 5, which has been converted to five levels of performance "Exemplary", "Very Good", "Good", "Marginal", and "Below Expectations" as per the department rubric for SLO 3. Data from the results of the assessment of student performance are presented in Table 10. The results show that out of the 12 submitted student reports, 25% were at the exemplary level, 42% at the very good level, 17% at the good level, 8% at the marginal level, and 8% were below expectations. Overall, 83.3% of the students were at least at the "Good" level while 67% of the project reports scored at least 90%, which is below the expected 75% mark (but quite a high bar for a very good project report as per the course rubric). Students struggled with managing their time and using the computer software MATLAB. In order to improve student performance in the future some class time will be provided to the students to familiarize themselves with the existing code and seek real-time assistance from the instructor.



SACRAMENTO STATE
Department of Civil Engineering

CE 231b – Structural Analysis II SPRING 2019

Name:

**Project I Evaluation**

| | |
|---|---|
| Code Modified | /5 |
| "Correct" Result Achieved | /2 |
| Convergence Studies | |
| Displacement | /1 |
| Stresses | /.75 |
| Presentation | /.5 |
| Other | |
| Mesh Generator | /.25 |
| Analysis of Data & Commentary | /.5 |
| Total | /10 |

Notes:

Figure 5 CE 261 (CE 231B) Project Rubric

**Table 10 SLO 3 Assessment Rubric Data from CE 261 Course in Spring 2019**

| Student | Exemplary (5) | Very Good (4) | Good (3) | Marginal (2) | Below Expectation (1) |
|---|---|---|---|---|---|
| Student 1 | | | X | | |
| Student 2 | | X | | | |
| Student 3 | | X | | | |
| Student 4 | | X | | | |
| Student 5 | X | | | | |
| Student 6 | X | | | | |
| Student 7 | | | | X | |
| Student 8 | | X | | | |
| Student 9 | | | | | X |
| Student 10 | X | | | | |
| Student 11 | | X | | | |
| Student 12 | | | X | | |

*SLO 3 Results: Transportation*

SLO 3 was assessed through direct measure of student performance in CE241 – Analysis and Control of Traffic Systems course. CE 241 is one of the core courses in the transportation engineering area and is taken by almost all the students specializing in transportation engineering. One requirement of this course is a comprehensive final exam. In this exam students were given a problem related to a time-space diagram and were requested to complete a process diagram of a fully actuated signal. They were also asked to explain all components of such a process diagram, including the difference between gap-out and max-out (Figure 6). This question is a typical example of a complex and practical civil engineering problem in the transportation engineering field.

The assessment data from this course was collected during the Spring 2021 semester for seven students taking the class. Data from the results of the assessment of student performance using the department rubric are presented in Table 11. The results show that approximately 72% of the students in the class are achieving the learning outcome (SLO 3) in the score category of 4 and 5, which is slightly below the expected 75% mark.

**Table 11 SLO 3 Assessment Rubric Data from CE 241 Course in Spring 2021**

| Student | Exemplary (5) | Very Good (4) | Good (3) | Marginal (2) | Below Expectation (1) |
|---|---|---|---|---|---|
| Student 1 | | X | | | |
| Student 2 | | X | | | |
| Student 3 | | X | | | |
| Student 4 | | X | | | |
| Student 5 | | | | X | |
| Student 6 | | X | | | |
| Student 7 | | | X | | |
| Student 8 | X | | | | |
| Student 9 | X | | | | |

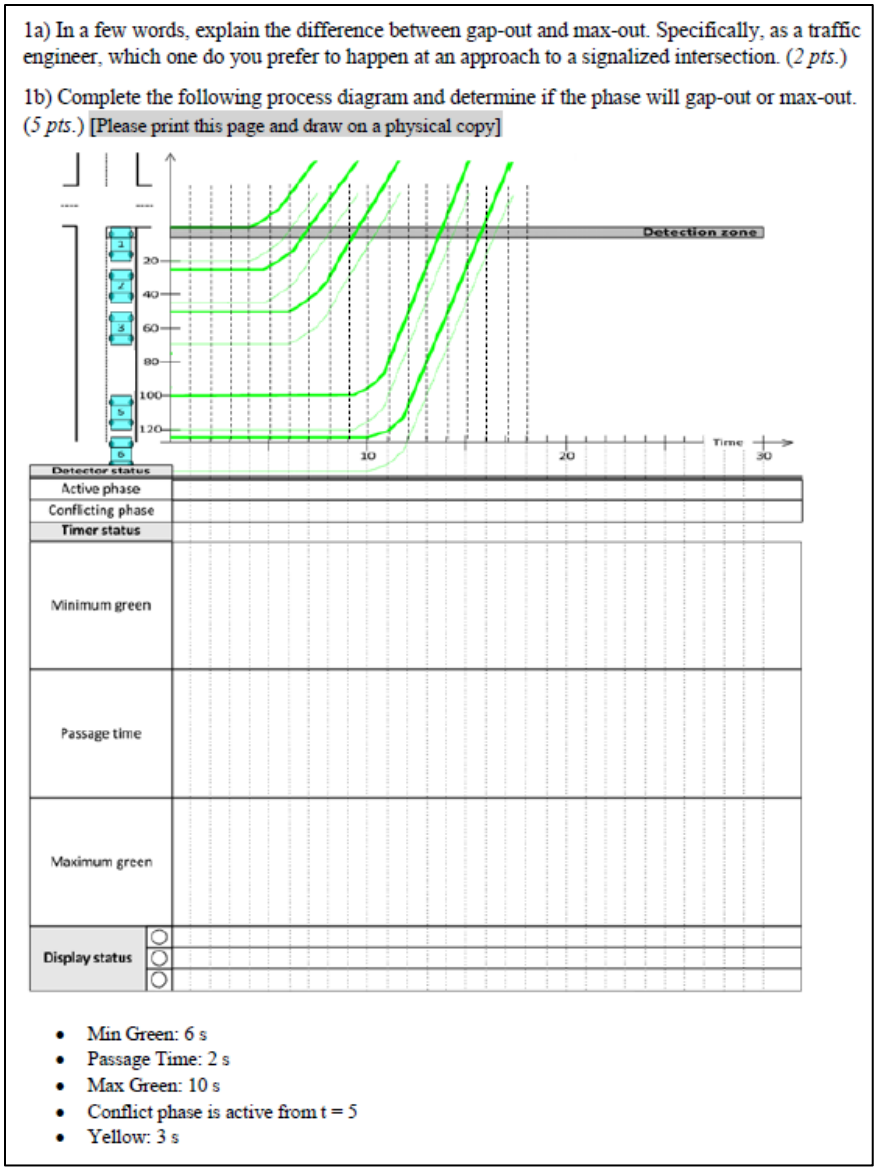



**Figure 6 SLO 3 Assessment Question from CE 241 Course**

*SLO 3 Results: Water Resources*

SLO 3 was assessed through direct measure of student performance in CE 232 – Groundwater Hydrology course. CE 232 is one of the core courses in the water resources engineering graduate program and is taken by almost all the graduate students specializing in water resources engineering. Students in this class are required to complete a project in which they build a complex, real-world numerical groundwater model of the California groundwater subbasin of their choice, using groundwater modeling software MODFLOW. The model should contain proper boundary and initial conditions and local hydrogeological properties. Students use their critical thinking skills to assess groundwater conditions in the subbasin and potentially assess the impact of managed aquifer recharge interventions in the area. The activities in this project are a typical example of a complex and practical civil engineering problem in the water resources engineering field directly related to SLO 3.

The assessment data from this course was collected during the Spring 2022 semester for nine students taking the class. Data from the results of the assessment of student performance using the Department rubric are presented in Table 12. The results show that out of nine submitted student reports, 22% were at the exemplary level, 56% at the very good level, 11% at the good level, and 11% were marginal. Overall, 88.9% of the students were at least at the "Good" level while 77.8% of the project reports were in the categories of 4 and 5 on the rubric, which is above the expected 75% mark. Students mentioned that they needed more time to properly build their models. In order to improve student performance in the future more time will be provided to the students to complete their models and more hands-on training sessions will be provided by the instructor.

**Table 12 SLO 3 Assessment Rubric Data from CE 232 Course in Spring 2022**

| Student | Exemplary (5) | Very Good (4) | Good (3) | Marginal (2) | Below Expectation (1) |
|---|---|---|---|---|---|
| Student 1 | | X | | | |
| Student 2 | | X | | | |
| Student 3 | | | X | | |
| Student 4 | | | X | | |
| Student 5 | | X | | | |
| Student 6 | X | | | | |
| Student 7 | | X | | | |

SLO4: Access, evaluate, and integrate information effectively and efficiently into original work

SLO4 was assessed using direct measures through student performance on an assignment in the CE 200: Civil Engineering Professional Writing course. Data from 20 students taking this course in the Fall 2021 semester were used. The assignment is a report about changes to laws, regulations, and civil engineering practice arising from a civil engineering failure within the United States. As part of the assignment students were required to identify, paraphrase, and evaluate previous investigations into the failure and to document the sources for any information in their report not considered common knowledge. IEEE style was required for in-text citations and reference lists.

The grading rubric used for the assignment is shown in Table 13. The rubric contains the following two performance indicators, "Investigations/Literature Review" and "Documentation of Sources", which were used as a measure of SLO 4.

## Table 13 CE 200 Assignment Rubric used for Evaluating SLO 4 Data

| | Meets Expectations (3 points) | Approaching Expectations (2 points) | Below Expectations (1 point) |
|---|---|---|---|
| Executive Summary | Provides an executive summary that concisely summarizes and accurately reflects the report | Provides an executive summary that mostly reflects the content of the report | Does not provide an executive summary that summarizes the report |
| Purpose | States the purpose of the report clearly | States the purpose ambiguously | Does not state the purpose |
| Background | Provides background information sufficient to put the report in context | Provides limited or overly general background | Provides no background or so little background that the context of the report is unclear |
| Investigations/Literature Review | Effectively paraphrases and thoughtfully evaluates all important related previous studies or investigations | Paraphrases some related previous studies or investigations, but does not always evaluate them | Paraphrases a few related previous studies or investigations, but does not evaluate them |
| Figures and Tables | Creates figures and tables that are clear, and captioned with a descriptive title | Creates figures and tables that are require some effort to understand; provides captions that are not sufficiently descriptive | Creates figures and tables that are poorly formatted and difficult to understand; does not provide captions |
| References to Figures and Tables | Refers to each figure or table by number and to specific, relevant features of each figure or table; clearly explains the contents of each figure or table | Refers to each figure or table by number but does not point the reader to specific, relevant features within each figure or table; does not clearly explain the contents of each figure or table | Does not refer to all figures and tables; does not provide captions; does not explain the contents of each figure or table |
| Claims | Makes claims of appropriate strength and provides adequate support for claims such as examples, data, references to figures and tables or other evidence | Sometimes makes claims that are too strong, providing inadequate support | Makes no claims or only claims of inappropriate strength, omitting support claims such as examples, data, references to figures and tables or other evidence |
| Discussion | Thoughtfully discusses findings and their implications; relates findings to the purpose of the study | Discusses findings and their implications overly briefly or generally; relates findings to the purpose of the study vaguely | Does not discuss findings and their implications |
| Conclusions | Effectively summarizes the report without using identical language as the executive summary, thoughtfully comments on next steps, and ends with a main takeaway | Summarizes report occasionally using redundant language, makes overly brief or general comments on next steps; does not end with main takeaway | Does not summarize report, comment on next steps or end with main takeaway |
| Achievement of Purpose | The report achieves or nearly achieves its purpose | The report for the most part achieves its purpose | The report does not achieve its purpose |
| Organization | Provides logical flow of information within paragraphs and between paragraphs; maintains the focus of each section | Provides logical flow of information within paragraphs and between paragraphs in most of the report; mostly maintains the focus of each section | Does not provide a flow of information within paragraphs and between paragraph that is logical; loses the focus in some sections |
| Documentation of Sources | Provides in-text citation and reference in IEEE format for all information that is not common knowledge | Provides in-text citation and reference in IEEE format for some information that is not common knowledge | Does not provide in-text citations or list of references for information that is not common knowledge |
| Language | Uses specific, unambiguous language with appropriate precision and without unnecessary words | Occasionally uses ambiguous or overly general language, unnecessary words or inappropriate precision | Frequently uses ambiguous or overly general language, unnecessary words or inappropriate precision |
| Grammar | Uses correct sentence structure and punctuation | Occasionally uses incorrect sentence structure or punctuation | Frequently uses incorrect sentence structure or punctuation |
| Other | Meets requirements for word count, line spacing, title page, table of contents | Mostly meets requirements for word count, line spacing, title page, table of contents | Does come close to meeting requirements for word count, line spacing, title page, or table of contents |

The levels of performance indicator "Investigations/Literature Review" in the rubric were *"Meets Expectations: Effectively paraphrases and thoughtfully evaluates all important related previous studies or investigations (3 points)", "Approaching Expectations: Paraphrases some related previous studies or investigations but does not always evaluate them (2 points)"* and *"Below Expectations: Paraphrases a few related previous studies or investigations but does not evaluate them (1 point)"*. 85% of students' reports were at least at the "Approaching Expectations" level and 75% of students' reports scored at least 2.5 points out of 3 points. Raw rubric data used in these calculations are presented in Table 14. For the "Documentation of Sources" performance indicator, the levels of performance in the rubric were *"Meets Expectations: Provides in-text citation and reference in IEEE format for all information that is not common knowledge (3 pts)", "Approaching Expectations: Provides in-text citation and reference in IEEE format for some information that is not common knowledge (2 points)"* and *"Below Expectations: Does not provides in-text citations or list of references for information that is not common knowledge (1 point)"*. Students performed less well in documenting their sources as seen in Table 14 with only 70% scoring at the "Approaching Expectations" level or above. Overall, the average for both performance indicators was 78% of the students meeting or exceeding the required threshold. While this meets the mark set by the Department for achieving the SLO, there is a need to further enhance student performance in at least some parts of this SLO given the results. CE 200 is a new course in the graduate program to enhance student writing competencies and there is room for improvement in both the course content and effective delivery given the knowledge gained from this assessment.

**Table 14 SLO 4 Assessment Rubric Data from CE 200 in Fall 2021**

| Student | Investigations/Literature Review | Documentation of Sources |
|---|---|---|
| Student 1 | 3 | 2.5 |
| Student 2 | 2.5 | 2.75 |
| Student 3 | 2.5 | 1 |
| Student 4 | 3 | 2.5 |
| Student 5 | 3 | 2.75 |
| Student 6 | 3 | 3 |
| Student 7 | 3 | 3 |
| Student 8 | 3 | 2.5 |
| Student 9 | 3 | 2.5 |
| Student 10 | 3 | 2 |
| Student 11 | 3 | 2 |
| Student 12 | 3 | 2 |
| Student 13 | 1 | 1 |
| Student 14 | 3 | 2.5 |
| Student 15 | 3 | 3 |
| Student 16 | 2 | 1 |
| Student 17 | 2 | 1 |
| Student 18 | 1 | 1 |
| Student 19 | 3 | 1 |
| Student 20 | 1.5 | 2.5 |

SLO 5: Build and sustain professional relationships and networks

SLO 5 was assessed through indirect measures using responses to the following questions from the survey of alumni of the graduate program (Appendix A).

- Please provide a list of professional engineering organizations that you are a member of e.g., ASCE, ITE, APWA, CEWA, SEAOCC, etc.
- Please rate the reasons below for joining one or more professional engineering organizations
    - Discover job prospects
    - Grow as a leader
    - Connect with a mentor
    - Build your network
    - Enhance your resume
    - Join a community
    - Innovate and influence industry standards
    - Access awards and scholarships

These questions were designed to obtain information on the level of involvement of alumni of the graduate program in various professional engineering organizations and the factors that influenced their decision to join such organizations. The graduate program in civil engineering emphasizes student participation in professional organizations through involvement in student chapters of such organizations. The Department of Civil Engineering currently has eight student chapters directly associated with professional engineering organizations, e.g., the American Society of Civil Engineers (ASCE), Institute of Transportation Engineers (ITE). These student chapters are highly active with student participation and will often coordinate activities with the professional societies in inviting speakers, participating in conferences, and other activities in the region. Alumni will typically transition into professional membership of engineering organizations after graduation given their interest and field of specialization. Involvement in professional engineering organizations supports continued professional learning and helps sustain professional networks and relationships, thus helping achieve the requirements of SLO 5.

The survey responses to the abovementioned questions are presented in Figure 7 and are indicative of the importance alumni place on building and sustaining professional relationships and networks through their involvement in professional engineering organizations. In response to the first question, 35 out of the 38 respondents were actively participating in one or more professional engineering organizations. When asked to rate the reasons for joining professional engineering organizations, alumni rated both the reasons “Build your network” and “Join a community” very highly. Both these factors are clear indicators of the importance and need for building and sustaining professional relationships and networks; and these results are a clear indication of the success of the graduate program towards SLO 5.

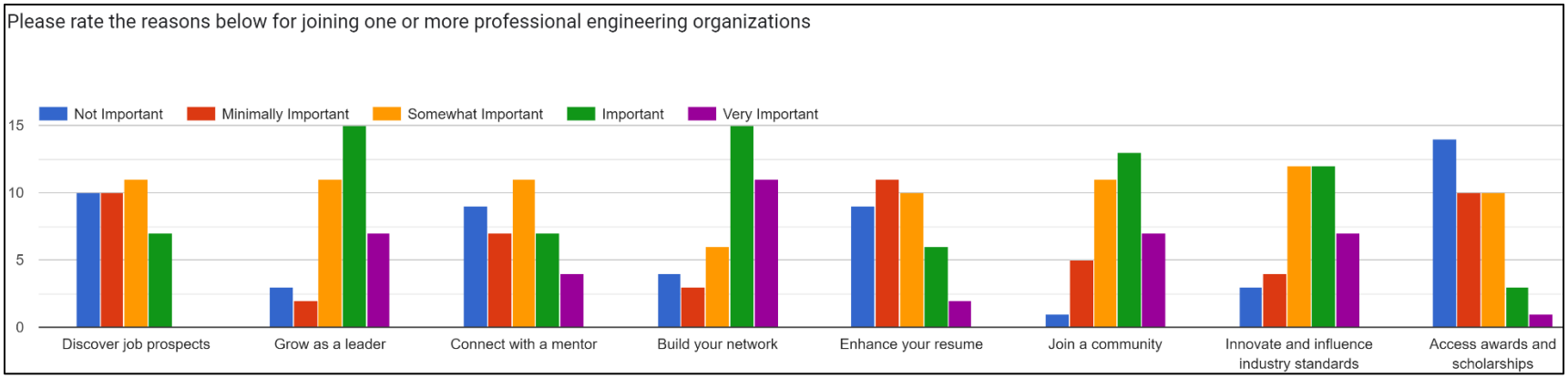



**Figure 7 MS in Civil Engineering Alumni Survey – Responses to Reasons for Joining Professional Engineering Organizations**

SLO 6: Understand the impact of engineering solutions in a broader global, economic, environmental, and societal context

SLO 6 is assessed using student performance on an assignment in CE 200: Civil Engineering Professional Writing. Data from 20 students taking this course in the Fall 2021 semester were used. The assignment is a report about changes to laws, regulations, and civil engineering practice arising from a civil engineering failure within the United States. The same assignment is used for assessing SLO 4. This assignment was deemed appropriate for measurement of achievement of SLO 6 because student reports discussed the economic, environmental, social and overall impacts of civil engineering failures, particularly impacts on the practice of civil engineering. For example, one student report titled "The Failures of the Interstate Highway System: A Case Study of the Embarcadero Freeway in San Francisco" discussed how this freeway depressed nearby property values, reduced local mobility by disrupting the local road network, and cut off views of the waterfront. The report also discussed how the removal of the freeway and subsequent redevelopment of the area reversed these negative impacts and started a trend of freeway removal within cities.

The grading rubric used for the assignment is shown in Table 15. The rubric contains the performance indicator "Achievement of Purpose" with levels of performance in the rubric as *"Meets Expectations: The report achieves or nearly achieves its purpose (3 pts)", "Approaching Expectations: The report for the most part achieves its purpose (2 pts)"* and *"Below Expectations: The report does not achieve its purpose (1 pt)"*. Raw rubric data is presented below in Table 15. 85% of students' reports were at least at the "Approaching Expectations" level and achieved the purpose of the assignment for the most part in relation to SLO 6. This also exceeds the 75% mark set by the Department for achievement of SLO 6.

**Table 15 SLO 6 Assessment Rubric Data from CE 200 in Fall 2021**

| Student | Achievement of Purpose |
|---|---|
| Student 1 | 3 |
| Student 2 | 2.5 |
| Student 3 | 1 |
| Student 4 | 3 |
| Student 5 | 3 |
| Student 6 | 3 |
| Student 7 | 3 |
| Student 8 | 2.5 |
| Student 9 | 3 |
| Student 10 | 2.5 |
| Student 11 | 2 |
| Student 12 | 2.5 |
| Student 13 | 1.5 |
| Student 14 | 2.5 |
| Student 15 | 2 |
| Student 16 | 2 |
| Student 17 | 1 |
| Student 18 | 2 |
| Student 19 | 2 |
| Student 20 | 1 |

SLO 7: Conduct independent research or study resulting in an in-depth evaluation and understanding of a specific problem statement or focused topic

SLO 7 was assessed using a direct measure of student performance from CE 500: Culminating Experience presentations. As described in detail in SLO 2 section, graduate students in the civil engineering program are required to take CE 500 and present their culminating experience work at a presentation session where their presentations are graded for various competencies using a prescribed rubric by faculty members attending the presentation as shown in Appendix B.

In order to evaluate SLO 7, the following performance indicators were utilized from the CE 500 evaluation rubric: "Apply Appropriate Language" and "Demonstrate Appropriate Content Knowledge". The performance of each student was based on their numeric scores from 1 to 4 on each of these performance indicators. The Department expects that at least 75% of the graduates obtain a score of 3 or above on these two performance indicators.

Table 16 shows the percentage of students obtaining an average score of 3 or higher for each of 5 semesters between Fall 2020 and Fall 2022 inclusive. The total number of students evaluated during this time was 39. At least 75% of students earned a score of 3 or higher for both the performance indicators "Apply Appropriate Language" and "Demonstrate Appropriate Content Knowledge" across all semesters except one. The overall combined average of scores on both the performance indicators for students over all five semesters is 83.5%, which is above the mark of 75% set by the Department. The raw data used to prepare Table 16 is presented in Appendix B.

**Table 16 CE 500 Culminating Experience Percent of Students with 3 or Higher Score on Performance Indicators Related to SLO 7**

| Performance Indicator | Fall 2020 (n = 6) | Spring 2021 (n = 7) | Fall 2021 (n = 6) | Spring 2022 (n = 16) | Fall 2022 (n = 4) | All Semesters (n = 39) |
|---|---|---|---|---|---|---|
| Apply Appropriate Language | 83% | 86% | 67% | 81% | 75% | 82% |
| Demonstrate Appropriate Content Knowledge | 83% | 100% | 67% | 81% | 75% | 85% |
| **Average** | 83% | 93% | 67% | 81% | 75% | **83.5%** |

**Discussion of Assessment Results**

The results of assessment of the seven student learning outcomes for the graduate program in civil engineering as presented in previous sections highlight how the program is performing in achieving its program learning outcomes. Although the program is doing well in most performance indicators used to measure achievement of SLO, there are some areas that need further enhancement and focus in addition to continuous changes and improvements to improve the quality of the program.

The assessment results of SLO 1 clearly demonstrate that graduates of the civil engineering master's program continue to do well and be successful in their areas of specialization through professional growth and effectiveness. Furthermore, alumni also appreciate the value the graduate program has given them in achieving growth and success in their professional careers.

In looking at assessment results of SLO 2, most alumni indicated that the graduate program helped improve their communication skills. Furthermore, data from assessment of the CE 500 Culminating Experience presentation session also indicates that students are meeting the expected communication skills required of the graduate program. Even with these results, the Department continues to deliberate the need for further improving the communication skills of civil engineering students in general, especially in view of feedback received from the Civil Engineering Department Industry Advisory Committees. Employers and industry partners have often emphasized to the Department that communication skills for civil engineering graduates are critical in their professional success. Hence, the Department has taken various steps to improve student communication skills, e.g., reducing the number of elective units in order to introduce a new graduate writing course (CE 200) in Fall 2021. These steps are designed to further enhance technical communication skills, both written and oral.

The assessment of SLO 3 is challenging given the small sample size of students in separate courses from each area of specialization in the graduate program. While the results from some areas of specialization courses show that SLO 3 is met by some areas in the program, other course data show some apparent deficiencies possibly due to the small sample size. The overall average number of students that met SLO 3 requirement combined from all areas of specialization was 67.4%, which is below the program target of 75% of the students achieving the SLO. This is a concern that the assessment committee in the Department will deliberate on to identify possible solutions going in to the future. A few suggestions have already been discussed at the Department and committee levels including e.g., the use of additional assessment strategies, data from additional courses to bolster the sample size, etc. The Department assessment committee will work with the faculty in each area if specialization in this regard. Additionally, the assessment committee will also continue to work with the instructors to make changes and improvements to their specific course activities as described in the previous sections in order to improve student learning in their respective courses.

The assessment results of SLO 4 show the program is meeting the requirement for graduate students. The addition of the graduate writing courses (CE 200) has been widely appreciated both by the students and industry partners, industry advisory committee members. The course, being relatively new, will continue to improve with minor changes and enhancements to adapt to the program learning outcomes and student needs. The Department was recently able to hire Dr. Joy Arbor who has a doctorate degree in English and works as a Technical Editor with the Office of Water Programs at Sacramento State, to teach the CE 200 course. The Department feels, given her background and expertise both in communication and the general civil engineering field, she will be able to bring valuable contributions to the structure of the course and student learning of communication skills.

The assessment results of SLO 5 shows the program is doing well in this area particularly given the historical strength of the student chapters in the Department and strong industry involvement and support. The Department of Civil Engineering prides itself in its strong industry connections and involvement through two industry advisory committees and various department sponsors. Given the nature of the Civil Engineering field, industry partners and professionals emphasize the importance of networking and building professional relationships for professional success. As such, the Department organizes three events in the academic year that provide opportunities for students and faculty to interact with industry professionals and learn how to network and build professional relationships. These events are the Annual Ken Kerri Endowment Fund Luncheon (Spring semester), Annual Civil Engineering Golf Tournament (Fall semester), and the Annual Evening with Industry event (Fall

semester). The onset of the COVID-19 pandemic did have a significant impact on student chapter activities and in-person events, which did continue virtually online, but not to the same effect. With return to in-person instruction, the Department has put special emphasis on revitalizing student clubs through advising and financial support from its discretionary funds and extra emphasis on encouraging students to attend in-person events. These efforts were rewarded with the largest ever Annual Golf Tournament event in the history of the department and a full house at the Annual Evening with Industry event in the Fall 2022 semester. The Department aims to continue these activities and efforts to provide students, especially graduate students, opportunities outside of the classroom to build and nurture networks that can help them become better professionals in their field.

The results of assessment of SLO 6 show that the program is doing well in this area. Civil engineers make decisions that inevitably impact societies and people living in them. Hence, it is imperative that civil engineers understand the impacts of their decisions on the general public and how best to address these, especially when dealing with publicly funded projects. As a result, almost all the courses in the civil engineering graduate program include, besides technical competencies, knowledge of how civil engineering decisions impact society from a local, national, to global scale.

The assessment results of SLO 7 indicate that the program is doing well is providing graduates the skills necessary to conduct independent research in their respective areas. The assessment data shows that students are able to effectively present information on their chosen topics and subject matter after their research, which requires them to gain and in-depth understanding of the topic and then be able to present their work in an appropriate manner. Within the five areas of specializations in the civil engineering graduate program, students work one-on-one with faculty who are experts in their fields to learn about a new topic, research new solutions, and gain in-depth understanding through their culminating experience. This also helps them in their profession after graduation since graduates can consider themselves as experts in the specific topic of their culminating experience.

## MAINTENANCE AND ENHANCEMENT OF THE PROGRAM QUALITY

The results of the assessment activities as presented in the previous section regarding each of the seven Student Learning Outcomes indicate that overall, the graduate program in civil engineering meets the intended program learning outcomes. The Department is pleased with the student performance in various SLO and responses from alumni to survey questions regarding various SLOs. The Department is confident that the graduate program is helping students and graduates develop the necessary skills desired by our graduates. Nevertheless, there continue to be challenges in some areas and opportunities for improvements that require continuous efforts in order to further enhance student learning and the quality of the program. As such, the Department periodically reviews issues and topics and takes necessary steps in this regard. These steps and initiatives are designed and focused on improving student learning and maintaining the quality and integrity of the graduate degree.

### Changes and Enhancement to the Program

The Department of Civil Engineering has made several changes and additions to the graduate program in the recent past to maintain and improve the quality of the program and to enhance student learning. Some of these changes were discussed previously in the discussion section of the assessment results. Others are summarized in subsequent sections.

#### Changes to Admission Procedures

The Department of Civil Engineering employs a holistic review strategy during the admission process in the graduate program. Applicants that do not meet the minimum admission requirements (bachelor's degree in civil engineering from an ABET accredited institution and GPA of 2.8) may be admitted to the program as conditionally classified graduate students based on a review of their resume and answers to two description questions on the admission application. In order to further enhance the admission process for such applicants and ensure the quality of the program, the Department in Fall 2018 instituted an additional requirement of GRE test score from applicants who did not meet the minimum admission requirements (starting from Fall 2019). This provided the Graduate Coordinator with an additional piece of information during the decision-making process as part of the holistic admission review strategy. As such, no minimum test score requirement was set. The Department had intended to review the impact of this change by tracking the admission numbers and quality of applicants in the future. However, the onset of the COVID-19 pandemic, issues with conducting GRE tests, and a university-wide policy to waive test scores for applicants during the pandemic has affected this process. The Department intends to revisit this subject once it is certain the impacts of the pandemic have subsided to a reasonable extent.

#### Curricular Changes and Improvements

As discussed previously, the Department replaced 3 units of elective requirement with the new graduate writing course (CE 200) to enhance the writing and communication skills of graduate students. Additionally, the Department undertook the arduous task of renumbering all the graduate courses. The Department also revised some graduate course titles to reflect the periodic changes/enhancements to the courses and developments in knowledge and topics covered in each course. As a result, a number of courses in the water resources area were revised with new course objectives in addition to some other

courses from other areas. The renumbering of courses was meant to group together courses from each area of specialization with specific starting numbers, e.g., courses in the environmental, geotechnical, structural, transportation, and water resources area would start with numbers “25X”, “27X”, “26X”, “24X”, and “23X”, respectively. This numbering system corresponds with the way undergraduate courses offered by the Department are numbered. The renumbering of graduate courses makes it easier for students to identify courses in their respective areas of specialization from the vast list of more than 35 graduate courses. Furthermore, it also helps in advising of graduate students for their academic plan.

In an effort to further enhance the curriculum, two new elective courses in Geographic Information Systems, CE 182 (Introduction to Geographic Information Systems in Civil Engineering) and CE 296I (Geographic Information Systems Applications in Civil Engineering) were developed. Although the CE 182 course was meant for the undergraduate program, it became a popular choice for graduate students since most of them did not have any background in the field of GIS. Therefore, instruction of the CE 296I course has been suspended given the preference and need for the introductory GIS course (CE 182) by the graduate students. A new graduate course called CE 245: Pavement Design was introduced in the transportation engineering area. This course is critical given the importance of the topic of road pavement design and its various aspects. The introduction of this course has significantly strengthened the graduate curriculum in the transportation area.

Student Orientation and Advising

A majority of the graduate students in the civil engineering master’s program are full-time professionals. Hence, coming to the campus outside of class times for advising and office hours can be a challenge for most of these students. Therefore, the Graduate Coordinator in the Civil Engineering Department has developed a dedicated Canvas course for graduate students called “CE Graduate Program Resources and Guide”. Canvas is the learning management system used by Sacramento State. All graduate students are added to this course at the time of admission. The Canvas course contains a step-by-step guide to navigate the various aspects of the civil engineering graduate program with details and tutorials on how to fill various forms, prepare for advancement to candidacy, and culminating experience, besides regular advising. The Canvas course also contains faculty profiles, office hours, and other important information and tips to help the graduate students. Graduate students in general have appreciated being able to find all information in one place and being able to access it in their personal time reducing the need for additional office hours meetings and giving the students clarity to be best prepared for the meeting all the requirements of the graduate program. Figure 8 shows a screenshot of the CE Graduate Program Resources and Guide Canvas course home page. In addition to advising enhancements, the Graduate Coordinator also organizes an orientation session for new incoming graduate students in order to introduce them to the program and help them familiarize with the Department and various resources available to the graduate students. These sessions are often conducted before the start of the Fall and Spring semesters.


**Figure 8 CE Graduate Program Resources and Guide Canvas Course**

Faculty Hiring

Faculty are essential to maintaining the quality of instruction in the graduate program. The Department of Civil Engineering currently has 13 full time tenured/tenure-track faculty teaching various graduate courses. Additionally, the Department has traditionally leveraged its strong industry connections to utilize temporary (part-time) faculty from the industry with expertise in various subjects. Most of these professionals have a doctorate or master's degree and are considered experts in their areas. They bring valuable industry experience and insight into their courses in the graduate program and along with the tenured/tenure-track faculty, provide a useful real-world perspective to the students in the graduate curriculum. The Department has seen a number of retirements and lateral movement of faculty in recent years even though there had been continuous hiring before the COVID-19 pandemic. In 2021, the Department approved a three-year faculty hiring plan, which is presented in Table 17 to further strengthen specific areas in the Department. Currently, the Department is only one year behind in this plan and hopes to achieve its targets by the academic year 2024/25. The influx of new full-time tenure-track faculty would significantly strengthen the Department's ability to increase the number of full-time faculty teaching graduate courses and mentoring graduate students in their CE 500 Culminating Experience. Furthermore, the structural engineering area has traditionally seen the greatest number of graduate students in the Department in the past. The goal of the Department, through this hiring plan, is to increase the size of graduate student population in other areas of civil engineering as well.

**Table 17 Civil Engineering Department Targets for Number of Faculty by Area and Hiring Plan**

| Area | 2020/2021 | 2021/2022 | 2022/2023 | 2023/2024 |
|---|---|---|---|---|
| Environmental | 2.0 | 2.0 | 2.0[3] | 3.0[3] |
| Geotechnical | 2.0 | 3.0 | 3.0 | 3.0 |
| Structural | 4.0 | 3.0 | 3.0 | 3.0 |
| Transportation[1] | 2.0 | 2.0 | 3.0[4] | 3.0 |
| Water Resources | 3.0 | 3.0 | 3.0 | 3.0 |
| Engineering Education | 0.0 | 0.0 | 0.0 | 1.0 |
| Full-time lecturer | 1.0 | 2.0[2] | 2.0 | 3.0[5] |
| Total | 14.0 | 15.0 | 16.0 | 19.0 |

Note: Underlined numbers indicate new faculty hires that academic year.
[1] Current department chair listed as 1.0 in transportation engineering
[2] Courses include graphics, surveying, statics, project skills, senior project
[3] one retirement in AY 2022/23; next hire focus on *air quality*
[4] Focus on *sustainable design, systems and planning*
[5] Focus on sustainable infrastructure

Laboratory Development and Enhancements

The Department of Civil Engineering is home to six laboratories; two related to structural engineering and one each for the remaining four areas of specialization. Each laboratory features advanced research and measurement equipment often identical to equipment graduates will use in industry such as the Acoustic Doppler Current Profiler (ADCP) for river flow measurement in the Hydraulics Laboratory. These labs are essential to the instructional capabilities of the Department at the undergraduate level and serve as a hub and catalyst for research activities in the graduate program. Graduate students

interested in CE 500 Culminating Experience Plan A (Thesis) and Plan B (Project) can utilize the lab facilities to conduct experiments, data analysis, and research using state-of-the-art equipment and software. The Department has a robust fundraising program, which raises upwards of $50,000 every year to allow for updating the equipment in these labs and other facilities in the Department. Furthermore, the Department will receive endowment funds periodically to support instruction, faculty, students, and laboratories in specific areas, e.g., in 2021, the Department received an endowment of $1.3 million from the late Jim Peterson, an alumnus of the graduate program, towards the Environmental Engineering area in general and the laboratory facilities. As another example, Clark Pacific Engineering, a national structural engineering company donated almost $250,000 to enhance the Concrete Laboratory in the Department in 2018. These types of funding opportunities allow the Department to maintain some of the best civil engineering labs in Northern California region and directly benefit graduate students in pursuing research in their fields of interest.

Most recently, the Department has invested almost $300,000 through university and private donations in the development of the Sustainable Technologies and Operations Research Center (STORC). STORC will serve as a hub for all research emphasizing sustainable options and solutions within and outside the field of civil engineering, with the Department faculty taking the lead. Graduate students have already undertaken research activities in STORC, e.g., with Dr. Jose Garcia in the Department of Civil Engineering. The Department aims to continue its efforts to enhance and redevelop its laboratory facilities for future improvements for the benefit of graduate students.

**Industry Advisory Committees**

The Department of Civil Engineering prides itself in its strong industry and alumni connections. The Department has two very active industry advisory committees as described in earlier sections, which are:

- Civil Engineering Program Industry Advisory Committee (CEPIAC)
- Environmental Engineering and Water Resources Engineering Graduate Program Industry Advisory Committee (EEWRIAC)

The purpose of these committees is to advise and guide the Department on all matters pertaining to the quality of both the undergraduate and graduate programs. Furthermore, the committees also help the Department in its fundraising activities and organization of the three annual events described previously. The EEWRIAC focuses on the graduate program in the environmental and water resources area and leverages the presence of the Office of Water Programs (OWP) on Sacramento State campus and its connections with industry as well as the Department of Civil Engineering. OWP generally hosts in-person EEWRIAC meetings and separate from the EEWRIAC provides opportunities for graduate students to work with OWP staff and its industry partners through its graduate fellowship program.

Both the EEWRIAC and CEPIAC meet twice a semester and the Department chair and faculty participate in these meetings. The Department engages the committees to provide periodic feedback on the curriculum in all areas of the undergraduate and graduate program. Additionally, the committees provide support to student chapters as well in the form of speakers and funding for participation in various activities.

**Future Assessment Plan and Activities**

As described in the previous section, the Department of Civil Engineering continues to engage in various activities to continuously improve and enhance the graduate program. While the Department has continued to engage in various assessment activities in the past, it constituted the first ever formal assessment committee in Fall 2021 to enhance and strengthen assessment activities for the future. The goal of the assessment committee is to streamline assessment processes and coordinate activities at the department level amongst all faculty. As a first step, the assessment committee has put together a formal assessment plan for the graduate program in the future, which is shown in Table 15.

**Table 18 Five-Year Assessment Plan for CE Graduate Program**

| Activity | AY 22/23 | AY 23/24 | AY 24/25 | AY 25/26 | AY 26/27 |
|---|---|---|---|---|---|
| **Direct measures (SLO 3)** | Spring 2023 – Environmental | Spring 2024 – Geotechnical | Spring 2025 – Structural | Spring 2026 – Transportation | Spring 2027 – Water Resources |
| **Direct measures (Other SLO)** | CE 500 -Every Semester | CE 500 -Every Semester<br>CE 200 – Fall Semester | CE 500 -Every Semester | CE 500 -Every Semester<br>CE 200 – Fall Semester | CE 500 -Every Semester |
| **Alumni Survey** | Fall 2022 | | Fall 2024 | | Fall 2026 |
| **Graduate Survey*** | Every semester | Every Semester | Every Semester | Every Semester | Every Semester |

*This will be developed by the assessment committee and the graduate coordinator in the future.

Some of the changes and improvements accomplished by the Department through the assessment committee were presented in this report, e.g., the revised graduate program alumni survey. Further changes and activities as per Table 18 and as highlighted in various sections in this report will be the main focus on this committee and the Department in general to further enhance the quality of the graduate program. Other opportunities identified by the Department to maintain success and continuous improvement that could be considered by the committee are listed below:

1. Review graduate courses curriculum and update content as per latest knowledge and research
2. Continue to align all graduate course learning outcomes with graduate program SLO and PLO
3. Address curricular challenges and opportunities, e.g., integration of sustainability and resilience related topics relevant to the field of civil engineering
4. Monitor admissions and enrollment in each area of specialization to ensure balance in the graduate student population
5. Develop a general strategic plan for the graduate program with short, medium, and long-term goals
6. Enhance graduate student advising and guidance for students seeking employment
7. Explore the feasibility of a blended undergraduate/graduate program to enhance access to the master's program for Sacramento State undergraduates
8. Continue to expand and enhance connections with alumni and industry partners.
9. Seek out opportunities to support students with awards, scholarships, and funding for research and professional travel

**CIVIL ENGINEERING GRADAUTE PROGRAM STUDENT ADMISSION AND ENROLLMENT PROFILE**

**Student Admissions**

California State University, Sacramento is one of 23 campuses in the California State University (CSU) System. The CSU system is the largest university system in the United States. The California Master Plan for Higher Education specifies that one of the primary missions of CSU's is to educate undergraduate and graduate students through the master's degree. The graduate program in the Department of Civil Engineering is one of the unique programs in Northern California that attracts applicants from throughout the state and internationally as well. Admissions in the graduate program generally tend to follow the trend in the performance of the economy, i.e., during periods of economic downturns, the program has observed increases in admission applications and vice versa. Given the performance of the economy in recent years, there has been a drop in admissions exacerbated by the impacts of the COVID-19 pandemic (Figure 9 and Table 19). However, the Department expects this to drop to reverse in the future given past trends and economic conditions, and particularly if expanded opportunities to study in the master's program such as the blended program are adopted. Note that not all students admitted enroll in the master's program eventually as admitted students may available opportunities at other institutions.

**Table 19 Civil Engineering Graduate Students Admissions**

| Term | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fall | 74 | 105 | 69 | 78 | 65 | 48 | 62 | 59 | 39 | 69 | 40 |
| Spring | | 4 | 29 | 41 | 44 | 42 | 33 | 22 | 31 | 18 | 19 |
| Total | 74 | 109 | 98 | 119 | 109 | 90 | 95 | 81 | 70 | 87 | 59 |

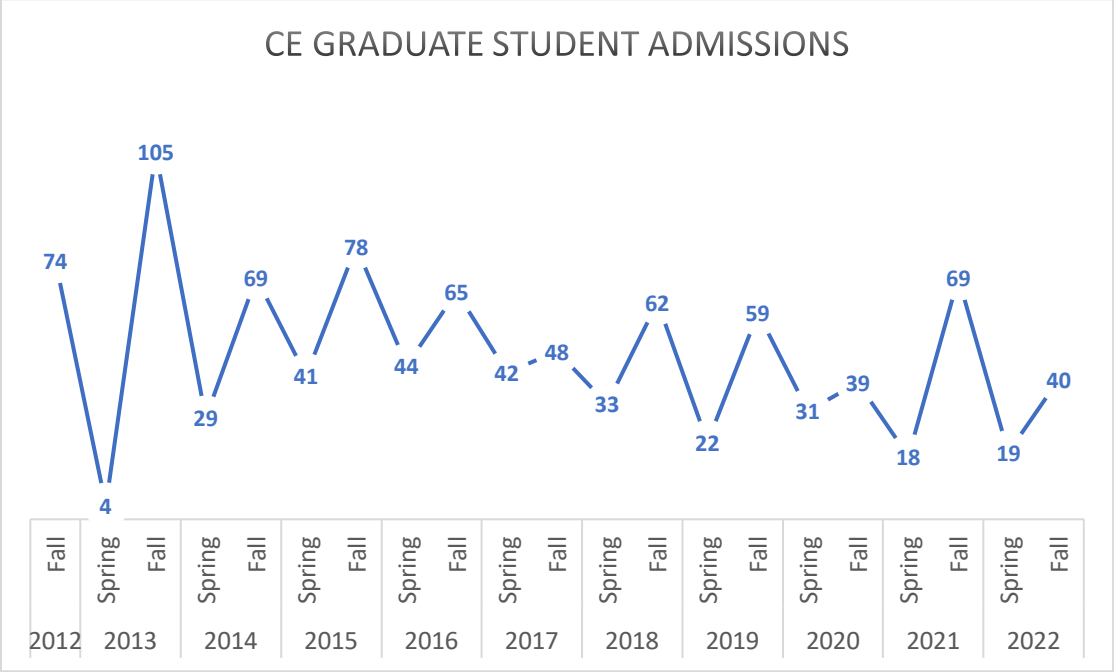



**Figure 9 Civil Engineering Graduate Student Admissions by Term**

**Student Enrollment Data**

Examination of the enrollment data as presented in Figure 10 shows a decline in total students since a peak enrollment in Fall 2018. A closer comparison of Fall 2018 enrollment with Fall 2022 shows a significant decrease in enrollment in the civil engineering graduate program. While there is no conclusive evidence for the reasons behind this trend, similar trends have been observed in other graduate programs in the College of Engineering and Computer Science (ECS). Furthermore, this trend follows the admissions pattern of reduction during better economic times and vice versa. The onset of the COVID-19 pandemic did have a significant impact on enrollment, especially within the international student population who could not travel to the United States of attend online school. The Department is optimistic that once the economic performance and the job market changes, the graduate program will observe a rise in admissions as observed in past trends especially during the 2008 economic recession.

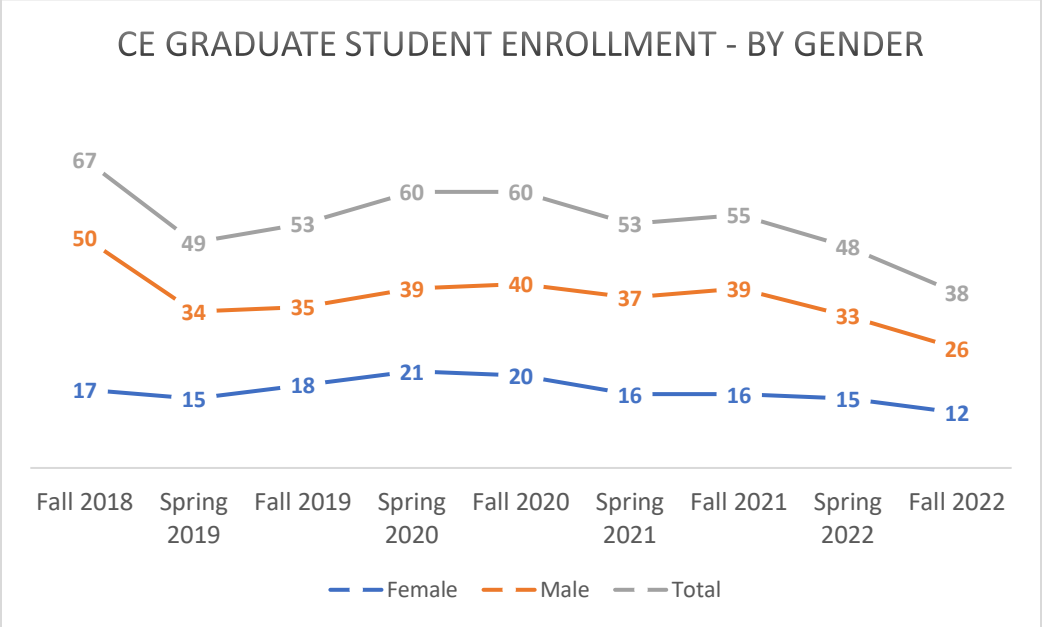



**Figure 10 Civil Engineering Graduate Student Enrollment by Gender**

One of the highlights of the Department of Civil Engineering is the diversity in its faculty. The Department currently has the highest proportion of female faculty in the College of ECS and a diversity of ethnicities amongst its faculty members. This diversity is well reflected in the graduate student population as well as shown in Figure 11. Most significantly, the Department of Civil Engineering has the second highest number of female graduate students of all programs in the College of ECS. Figure 12 shows the number of graduate degrees awarded by the program in the Department of Civil Engineering.

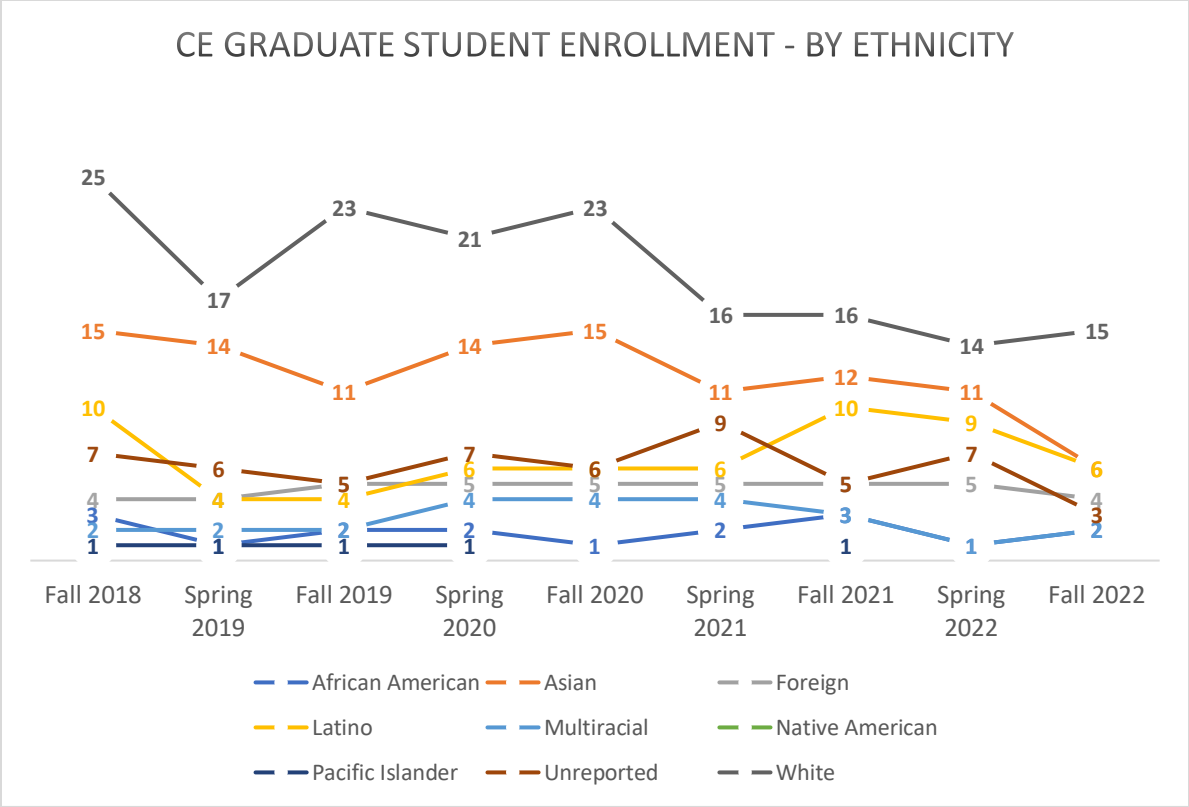



**Figure 11 Civil Engineering Graduate Student Enrollment by Ethnicity**

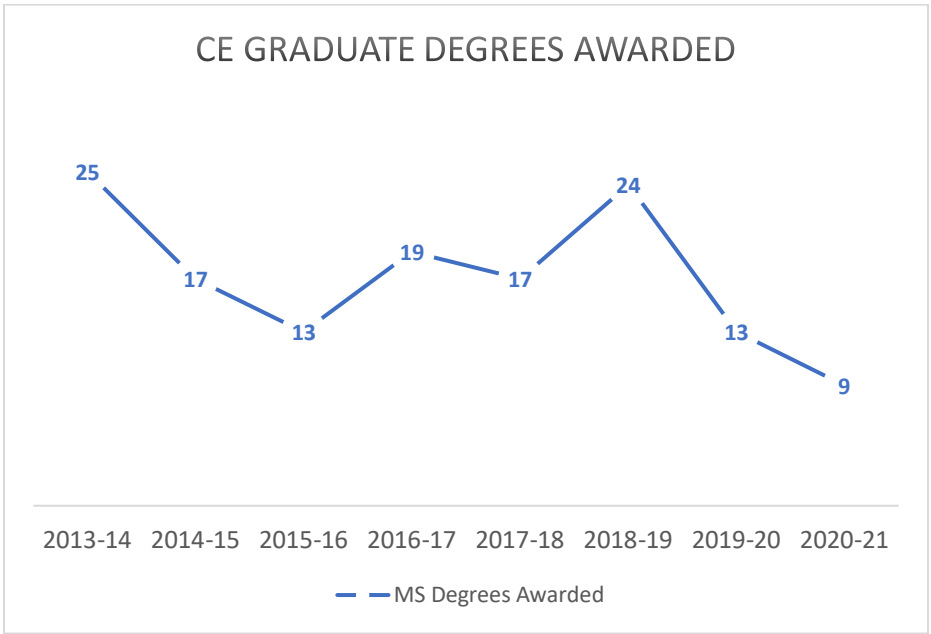



**Figure 12 CE Graduate Degrees Awarded by Term**

**Appendix A: MS in Civil Engineering Alumni Survey**

# Sac State Civil Engineering MS Program Alumni Survey

*Greetings from the Dept. of Civil Engineering at Sacramento State University.*

***As Alumni of the Sac State MS in Civil Engineering Program**, I would like to invite you to fill out the following survey in order to help the Dept. in its efforts to continue to improve the MS in Civil Engineering program to serve the needs of our students and industry partners. Thank you in advance for your responses.*

***You are welcome to submit your responses anonymously** or you can submit your name and contact information, which is optional.*

* Required

## Background Information

1. Your name and email? (Optional)

2. Year and Semester of MS Graduation? (e.g., Spring 2018)

3. MS Degree Specialization? *

   *Mark only one oval.*

   - ◯ Environmental Engineering
   - ◯ Geotechnical Engineering
   - ◯ Structural Engineering
   - ◯ Transportation Engineering
   - ◯ Water Resources Engineering
   - ◯ Other

4. Undergraduate Degree Institution?

_____

5. What is the nature of your job responsibilities in your current position? e.g., design, planning, operation, construction, research and development, oversight, working outside of engineering?, etc.

_____

_____

_____

_____

_____

6. Number of years of professional experience?

*Mark only one oval.*

- ◯ 0 - 3 years
- ◯ 3 - 5 years
- ◯ 6 - 10 years
- ◯ 10 - 15 years
- ◯ 15+ years

7. Number of years with current employer?

*Mark only one oval.*

- ◯ 0 - 3 years
- ◯ 3 - 5 years
- ◯ 6 - 10 years
- ◯ 10 - 15 years
- ◯ 15+ years

**Professional Licensure**

8. Do you have a P.E. License? *

*Mark only one oval.*

- ◯ Yes *Skip to question 9*
- ◯ No *Skip to question 11*

**P.E. Questions**

9. Date P.E. License Received? (approximate date is ok)

_____

*Example: January 7, 2019*

10. How often do you use your P.E. Stamp?

*Mark only one oval.*

- ◯ Frequently
- ◯ Occasionally
- ◯ Rarely
- ◯ Never

*Skip to question 12*

**E.I.T**

11. Do you have E.I.T. Certification?

*Mark only one oval.*

- ◯ Yes
- ◯ No

## Membership of Professional Engineering Organizations

12. Please provide a list of professional engineering organizations that you are a member of e.g., ASCE, ITE, APWA, CEWA, SEAOCC, etc.

13. Please rate the reasons below for joining one or more professional engineering organizations

*Mark only one oval per row.*

| | Not Important | Minimally Important | Somewhat Important | Important | Very Important |
|---|---|---|---|---|---|
| **Discover job prospects** | ◯ | ◯ | ◯ | ◯ | ◯ |
| **Grow as a leader** | ◯ | ◯ | ◯ | ◯ | ◯ |
| **Connect with a mentor** | ◯ | ◯ | ◯ | ◯ | ◯ |
| **Build your network** | ◯ | ◯ | ◯ | ◯ | ◯ |
| **Enhance your resume** | ◯ | ◯ | ◯ | ◯ | ◯ |
| **Join a community** | ◯ | ◯ | ◯ | ◯ | ◯ |
| **Innovate and influence industry standards** | ◯ | ◯ | ◯ | ◯ | ◯ |
| **Access awards and scholarships** | ◯ | ◯ | ◯ | ◯ | ◯ |

## Sac State MS in Civil Engineering Program

14. In what way did the master's degree help you? (Select all that applies)

*Check all that apply.*

- [ ] Secure a raise or better salary
- [ ] Handle more complex projects and problems
- [ ] Achieve personal goal
- [ ] Get a promotion
- [ ] Get a new job offer
- [ ] Other: _____

15. How was your graduate degree supported?

*Check all that apply.*

- [ ] Personal Finance
- [ ] Financial Loan
- [ ] Employer Supported
- [ ] Scholarships and/or On-Campus Student Employment
- [ ] Other: _____

**Sac State MS in Civil Engineering Program**

16. Please rate how much the Graduate Program helped you improve your **Communication Skills**

*Mark only one oval.*

| | |
|---|---|
| Not at all | |
| 1 | ◯ |
| 2 | ◯ |
| 3 | ◯ |
| 4 | ◯ |
| 5 | ◯ |
| A great deal | |

17. Please provide suggestions on improving the program in the area of **Communication Skills**

_____

18. Please rate how much the Graduate Program helped you improve your **Analytical Skills**

*Mark only one oval.*

Not at all

1 ⬭

2 ⬭

3 ⬭

4 ⬭

5 ⬭

A great deal

19. Please provide suggestions on improving the program in the area of **Analytical Skills**

20. Please rate how much you would recommend the Graduate Program to others in your field

*Mark only one oval.*

Not at all

1 ⬭

2 ⬭

3 ⬭

4 ⬭

5 ⬭

A great deal

**Sac State MS in Civil Engineering Program**

21. Which graduate class benefited you the most or had the most impact on you and why?

22. Which graduate class benefited you the least and why? How could it be changed to increase the benefit to students?

23. For your Culminating Experience (CE 500), which option did you choose?

*Mark only one oval.*

- ◯ Plan A (Thesis)
- ◯ Plan B (Project)
- ◯ Plan C (Directed Study and Comprehensive Exam)

24. How was your experience of going through the Culminating Experience course (CE 500) and what did you gain from the course? Why did you choose your selected option (A, B, or C)?

**Sac State MS in Civil Engineering Program**

25. Please rate the following factors if you were to select the MS in Civil Engineering graduate program at Sac State now *

*Mark only one oval per row.*

| | Not Important | Minimally Important | Somwhat Important | Important | Very Important |
|---|---|---|---|---|---|
| **School's academic reputation** | ◯ | ◯ | ◯ | ◯ | ◯ |
| **Program's academic reputation** | ◯ | ◯ | ◯ | ◯ | ◯ |
| **Convenient schedule** | ◯ | ◯ | ◯ | ◯ | ◯ |
| **Cost** | ◯ | ◯ | ◯ | ◯ | ◯ |
| **Student support services** | ◯ | ◯ | ◯ | ◯ | ◯ |
| **Personal attention from faculty** | ◯ | ◯ | ◯ | ◯ | ◯ |
| **Small class sizes** | ◯ | ◯ | ◯ | ◯ | ◯ |

26. If you were to select a graduate program now, how desirable do you find the following program characteristics? *

*Mark only one oval per row.*

| | Not Desireable | Minimally Desireable | Somwhat Desireable | Desireable | Very Desireable |
|---|---|---|---|---|---|
| **Fully face-to-face (in class) program** | ◯ | ◯ | ◯ | ◯ | ◯ |
| **Fully online program** | ◯ | ◯ | ◯ | ◯ | ◯ |
| **Hybrid format: 50/50 face-to-face and online** | ◯ | ◯ | ◯ | ◯ | ◯ |
| **75% face-to-face, 25% online** | ◯ | ◯ | ◯ | ◯ | ◯ |
| **25% face-to-face, 75% online** | ◯ | ◯ | ◯ | ◯ | ◯ |
| **Semester format (15-16 weeks)** | ◯ | ◯ | ◯ | ◯ | ◯ |
| **Accelerated format (5-7 weeks, one class at a time)** | ◯ | ◯ | ◯ | ◯ | ◯ |
| **Blended Bachelor's and Master's degree program** | ◯ | ◯ | ◯ | ◯ | ◯ |

| | | | | | |
|---|---|---|---|---|---|
| **Mostly or all early morning or evening classes** | | | | | |
| **Mostly or all day classes** | | | | | |

Wrap up

27. Please provide any additional comments and feedback to improve the MS in Civil Engineering program at Sacramento State

## Appendix B: MS in Civil Engineering Culminating Experience Presentation Rubric and Data

**Civil Engineering MS Culminating Requirement Presentation Review**

Student Name: _____

CE500 Plan (circle one): A B C

| Performance Indicator | Assessment Score | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| ***Devise an organized presentation***<br>***Score =*** _____ | Lacked overall (global) organization and lacked detailed-level organization | Organization was mostly appropriate, but presentation of details lacked clarity | Organization was appropriate, but presentation of details lacked clarity | Presentation organization in a clear and consistent that was appropriate for subject matter |
| ***Apply appropriate language***<br>***Score =*** _____ | Language is ambiguous, incorrect terminology, confusing, does not consider audience | Language is often ambiguous, mostly correct terminology, clear, misses audience | Language is mostly unambiguous, correct terminology, enhance presentation, considers audience | Language is unambiguous, correct for subject matter, enhance presentation, and appropriate for audience |
| ***Demonstrate appropriate content knowledge***<br>***Score =*** _____ | Failed to demonstrate knowledge of subject and failed to provide concise explanations of the issue(s). Multiple factual errors in presentation or in answering questions. | Speaker demonstrated weak knowledge of subject and failed to synthesize the issues. Presentation or answers to questions contained several factual errors or errors in logic | Speaker demonstrated adequate knowledge of subject and provided good explanations of the issues, but presentation or answers to questions contained a few factual errors or errors in logic. | Speaker demonstrated strong knowledge of subject and provided concise explanations of the entire issue. |
| ***Deliver content effectively***<br>***Score =*** _____ | Mannerisms, smoothness, pace and tone detract from the understandability of the presentation, speaker appears uncomfortable | Mannerisms, smoothness, pace and tone make the presentation understandable, and speaker appears tentative | Mannerisms, smoothness, pace and tone make the presentation interesting, and speaker appears comfortable | Mannerisms, smoothness, pace and tone make presentation compelling, speaker appears polished and confident |
| ***Develop visual materials which effectively support oral delivery (e.g., slides)***<br>***Score =*** _____ | Visual materials are unclear in content and visual presentation; materials not integrated well with presentation | Visual materials are mostly clear in content and visual presentation; materials regularly referenced by speaker | Visual materials are mostly clear in content and visual presentation with some exceptions; materials consistently referenced by speaker | Visual materials are clear in content and visual presentation; materials integrated seamlessly into presentation |
| ***Total Score =*** _____***/20*** | | | | |

### SLO 2 and 7 Assessment Rubric Data from CE 500 Presentations Fall 2020 to Fall 2022

| Student | Semester | Devise an organized presentation | Apply appropriate language | Demonstrate appropriate content knowledge | Deliver content effectively | Develop visual materials which effectively support oral delivery |
|---|---|---|---|---|---|---|
| Student 1 | Fall 2020 | 3.3 | 3.5 | 3.3 | 3.2 | 4.0 |
| Student 2 | Fall 2020 | 3.4 | 3.0 | 3.6 | 2.8 | 3.4 |
| Student 3 | Fall 2020 | 3.7 | 3.5 | 3.7 | 3.2 | 3.7 |
| Student 4 | Fall 2020 | 2.5 | 2.2 | 2.3 | 1.7 | 3.0 |
| Student 5 | Fall 2020 | 3.8 | 3.8 | 3.4 | 3.2 | 3.8 |
| Student 6 | Fall 2020 | 3.5 | 3.5 | 3.5 | 3.0 | 4.0 |
| Student 7 | Spring 2021 | 4.0 | 4.0 | 4.0 | 3.7 | 4.0 |
| Student 8 | Spring 2021 | 4.0 | 3.8 | 4.0 | 3.8 | 4.0 |
| Student 9 | Spring 2021 | 4.0 | 4.0 | 3.4 | 3.6 | 4.0 |
| Student 10 | Spring 2021 | 3.3 | 3.0 | 3.0 | 2.5 | 2.8 |
| Student 11 | Spring 2021 | 3.7 | 4.0 | 3.7 | 3.3 | 3.7 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Student 12 | Spring 2021 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 |
| Student 13 | Spring 2021 | 3.3 | 2.7 | 3.3 | 2.3 | 3.7 |
| Student 14 | Fall 2021 | 3.0 | 3.3 | 3.5 | 3.5 | 2.5 |
| Student 15 | Fall 2021 | 2.4 | 2.6 | 2.8 | 2.6 | 2.8 |
| Student 16 | Fall 2021 | 3.0 | 2.3 | 2.7 | 2.5 | 2.7 |
| Student 17 | Fall 2021 | 3.4 | 3.0 | 3.2 | 3.2 | 3.2 |
| Student 18 | Fall 2021 | 3.7 | 3.3 | 3.7 | 3.2 | 3.5 |
| Student 19 | Fall 2021 | 3.5 | 3.7 | 3.8 | 3.3 | 3.5 |
| Student 20 | Spring 2022 | 3.5 | 3.0 | 2.5 | 3.0 | 3.0 |
| Student 21 | Spring 2022 | 3.3 | 3.7 | 3.7 | 3.3 | 3.0 |
| Student 22 | Spring 2022 | 3.7 | 3.7 | 3.3 | 3.3 | 3.7 |
| Student 23 | Spring 2022 | 4.0 | 3.8 | 3.5 | 3.0 | 3.0 |
| Student 24 | Spring 2022 | 3.2 | 3.0 | 3.4 | 2.6 | 3.2 |
| Student 25 | Spring 2022 | 3.0 | 2.8 | 3.0 | 3.0 | 3.0 |
| Student 26 | Spring 2022 | 4.0 | 4.0 | 3.5 | 4.0 | 4.0 |
| Student 27 | Spring 2022 | 3.5 | 3.5 | 3.5 | 2.5 | 3.5 |
| Student 28 | Spring 2022 | 2.0 | 2.5 | 2.5 | 2.5 | 2.0 |
| Student 29 | Spring 2022 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| Student 30 | Spring 2022 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| Student 31 | Spring 2022 | 3.0 | 3.0 | 3.0 | 2.0 | 2.0 |
| Student 32 | Spring 2022 | 2.0 | 2.3 | 2.7 | 1.7 | 2.3 |
| Student 33 | Spring 2022 | 4.0 | 3.5 | 3.5 | 4.0 | 3.5 |
| Student 34 | Spring 2022 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Student 35 | Spring 2022 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Student 36 | Fall 2022 | 4.0 | 3.3 | 3.8 | 3.8 | 4.0 |
| Student 37 | Fall 2022 | 3.3 | 2.8 | 2.8 | 2.8 | 3.5 |
| Student 38 | Fall 2022 | 3.8 | 3.5 | 4.0 | 3.3 | 4.0 |
| Student 39 | Fall 2022 | 3.4 | 3.2 | 3.0 | 2.8 | 2.8 |

## Appendix C: SLO 3 Related Information

### Evaluation Rubric for SLO 3

**Department of Civil Engineering**

**Assessment of the Graduate Program**

Rubric for Learning Outcome - Technical Competence for Solving Complex Problems

SLO3: Identify, analyze, and solve complex practical civil engineering problems in a selected field of study in civil engineering.

| Exemplary | Very Good | Good | Marginal | Below Expectation |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |
| • The calculations are documented as a professional engineering calculation that supports any engineering decision.<br>• Clearly and consistently documented definition and outline of the engineering problem.<br>• Clearly documented assumptions and requirements of the problem.<br>• Clearly stated approach and solution of the problem at hand.<br>• Clearly labeled schematics and sketches.<br>• Demonstrates command of the theory and application beyond expectation. | • The calculations are documented as a professional engineering calculation that supports any engineering decision with no gaps.<br>• Documented definition and outline the engineering problem with minor gaps.<br>• Documented assumptions and requirements of the problem with minor gaps.<br>• Stated approach and solution for the problem at hand with minor gaps.<br>• Labeled schematics and sketches with minor gaps.<br>• Demonstrates clear understanding of the theory and application. | • The calculations are documented as a professional engineering calculation that supports any engineering decision with some gaps.<br>• Sparsely documented definition and outline the engineering problem with some gaps.<br>• Sparsely documented assumptions and requirements of the problem with some gaps.<br>• Inconsistent documentation of the approach and solution for the problem at hand with minor gaps.<br>• Inconsistent labeling of schematics and sketches.<br>• Demonstrates understanding of the theory and application with minor gaps. | • The calculations are sparsely documented as a professional engineering calculation that supports any engineering decision with some gaps.<br>• Sparsely documented definition and outline the engineering problem with no consistency.<br>• Inconsistent documentation of assumptions and requirements of the problem.<br>• Inconsistent documentation of the approach and solution for the problem at hand with some gaps.<br>• Inconsistent labeling of schematics and sketches.<br>• Demonstrate some understanding of theory and application with some gaps. | • The calculations are not documented as a professional engineering calculation that supports any engineering decision.<br>• No clear documentation of definition and outline the engineering problem.<br>• No clear documentation of assumptions and requirements of the problem.<br>• No clear documentation of the approach and the solution for the problem at hand.<br>• Schematics and sketches are not labeled.<br>• No clear understanding of theory and application. |

**CE 232 (Old Course No. CE 276): Ground Water Hydrology Course Project**


CALIFORNIA STATE UNIVERSITY, SACRAMENTO

College of Engineering and Computer Science

Civil Engineering

# CE 276: Groundwater Hydrology

# Project: Groundwater Modeling

Based on the conceptual model you created for Assignment 3, build a numerical groundwater model using ModelMuse and MODFLOW-NWT. The model should contain the following:

- ✓ Boundary Conditions
- ✓ Initial Conditions
- ✓ Hydrogeological properties

**Steps for building your model:**

- Start by importing a polygon of the model boundary.
- Create a grid encompassing the model domain (spatial discretization on x and y).
- Define the ground elevation of your model (using a DEM).
- Define the number, type and thickness of the aquifers (vertical discerization – z direction). I suggest keeping things as simple as possible. Don't try to model too many aquifers for example. It is better to focus on one aquifer if possible.
- Select a time period for running your model (based on the available data) and select the number of stresses of your model (typically we define two stresses per year – one representing the dry and one representing the wet season). I suggest the upper limit for the duration to be 5 yrs.
- Set the model boundary conditions.
- Set the model initial conditions and choose the type of simulation you like to perform (steady state or transient mode).
- Set the necessary input values for the hydrogeological properties (hydraulic conductivity, specific yield etc.) based on initial estimates. As a rule of thumb: Kx = Ky and Kz = 0.1Kx.

**Steps for model calibration/sensitivity analysis:**

- Select up 7-10 calibration targets (wells for which you have water level information).
- To keep things simple, you will calibrate your model by adjusting the hydraulic conductivity and boundary conditions (BCs) only.
- Adjust K and BCs until your modeled hydraulic heads match the observed to a satisfactory degree (ModelMuse has an option for this; we will go over it during the ModelMuse workshop).
- When you are satisfied with your calibration, analyze and present your results. This is typically done in the form of maps and tables. Even if your calibration is not complete that is ok, given the time constrains of this exercise.
- Perform a sensitivity analysis on hydraulic conductivity only by adjusting the calibrated values by +- 10% and +-20%.

**Optional**

If you have time you could implement a managed aquifer recharge intervention at a location of interest (where the groundwater levels have declined significantly) using either an infiltration basin or recharge wells (bonus – 5 extra points).

**Notes:** Start with the simplest model possible (e.g. homogeneous K, simple BCs) that is still complete (has all the necessary components i.e. initial and boundary conditions and model parameters). Make sure the model runs. Then start adding complexity to it (heterogeneity for example). Do not apply to many changes at once, and remember to make sure your model still runs before proceeding with the next change.

**What to submit on canvas:**

Write a **report**, stating the purpose of your model, documenting your modeling efforts and presenting your results and create a **presentation** to be presented in class on the last day of classes. Submit:

1) The modeling report
2) The modeling presentation
3) The **ModelMuse file (.gpt file)**
4) All the GIS (and any other) input files you uploaded into the model

SACRAMENTO STATE
Department of Civil Engineering

**CE 231B – Structural Analysis II** **SPRING 2019**

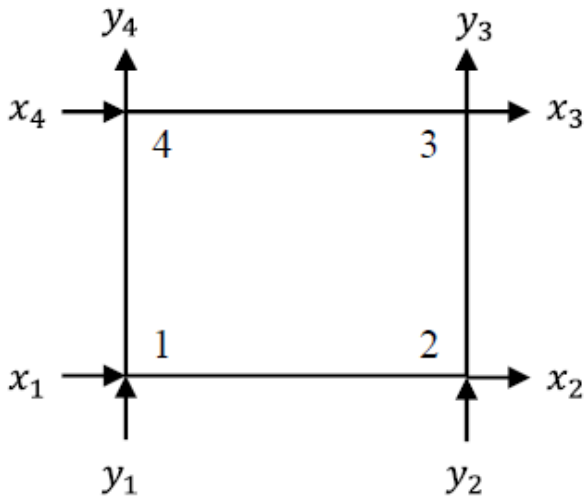
## PROJECT I

**Due April 4, 2019**

Derive the full stiffness matrix and load vector for the 4-node rectangular finite element shown below. Assume that the applied loads are only applied at the nodes (no need to calculate consistent nodal loads due to body or surface loads).

Implement the derived stiffness matrix into the MatLab program. Choose a problem with known 'exact' answer and conduct convergence studies to see how fast the solution converges to the exact answer.

Submit a comprehensive report documenting your efforts along with a copy of the revised program by email.



# CE 252: Environmental Quality Processes II – Final Exam

CALIFORNIA STATE UNIVERSITY, SACRAMENTO
College of Engineering and Computer Science
Department of Civil Engineering

CE 252B: Environmental Quality Processes II Spring 2020

Final Exam – May 11, 2020

90 minutes

Total points of 90

Closed book – Open notes

No laptop, tablet, cellphone, camera or any other electronic device except an FE qualified calculator is allowed during the test or test review. No part of the test should be copied at any time for any reason.

Name _____

Total Points _____

**PART B. NUMERICAL QUESTIONS**

1. (15 pts) Design a CMFR reactor to achieve an average 95% nitrification in a municipal wastewater following biological treatment for BOD removal. The treatment plant capacity is 100,000 $m^3$ per day, influent ammonium as nitrogen ($NH_4 - N$) concentration is 40 mg/L and it is assumed that there is no inert biomass concentration in the influent. The following organism kinetic parameters apply:

Y = 0.4 g VSS/g $NH_4$-N
$\hat{q}$= 3.5 g $NH_4$-N/g VSS-d
K = 1.0 mg $NH_4$-N/L
b = 0.2/d

2. (20 pts) For a 10 MGD wastewater treatment plant, you are hired to design an activated sludge process. Calculate the required/recommended hydraulic retention time (HRT) and sludge retention time (SRT). Assume there is no active biomass in the influent. The influent substrate concentration is 750 mg $BOD_L$/L and influent inert biomass is measured as 50 mg VSS/L.

Assume the following microbial kinetic parameters:

$\hat{q}$ = 10 mg $BOD_L$/mg $VSS_a$-d
K = 10 mg $BOD_L$/d
Y = 0.4 mg $VSS_a$/mg $BOD_L$
b = 0.1/d
$f_d$ = 0.8

3. (20 pts) Based on a preliminary design of an activated sludge process, SRT is calculated as 5 days. Estimate the effluent quality in terms of TSS and $BOD_5$ in this process. You can use the following microbial kinetics parameters and any parameters from the previous question if needed.

$q_{UAP}$ = 2 mg $COD_p$/mg $VSS_a$-d
$q_{BAP}$ = 0.1 mg $COD_p$/$VSS_a$-d
$K_{UAP}$ = 100 mg $COD_p$/L
$K_{BAP}$ = 80 mg $COD_p$/L
$k_1$ = 0.13 mg $COD_p$/mg $BOD_L$
$k_2$ = 0.09 mg $COD_p$/mg $VSS_a$-d

| Student | P.I. 1 | P.I. 2 | P.I. 3 | P.I. 4 | **Average** |
|---|---|---|---|---|---|
| #1 | 5 | 4 | 4 | 4 | **4.25** |
| #2 | 5 | 5 | 4 | 5 | **4.75** |
| #3 | 4 | 5 | 5 | 4 | **4.5** |
| #4 | 3 | 1 | 1 | 2 | **1.75** |
| #5 | 3 | 3 | 1 | 2 | **3.25** |
| #6 | 3 | 2 | 3 | 3 | **2.75** |
| #7 | 3 | 3 | 3 | 4 | **3.5** |

## CE 252: Environmental Quality Processes III – Final Exam

CALIFORNIA STATE UNIVERSITY, SACRAMENTO
College of Engineering and Computer Science
Department of Civil Engineering

CE 252C: Environmental Quality Processes III Fall 2020

Final Exam – 90 minutes

Closed book – Open notes

No laptop, tablet, cellphone, camera or any other electronic device except an FE qualified calculator is allowed during the test or test review. No part of the test should be copied at any time for any reason.

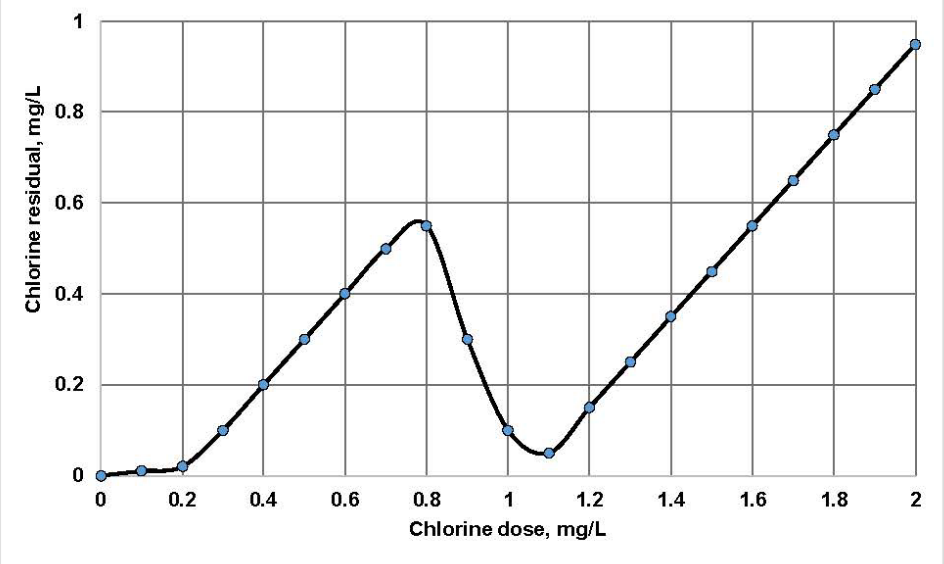
Name _____

Total Points _____

Your solutions must be presented in neat, organized, and easy to follow manner. Show all the steps for full credit. Your test will be graded based on what is written down on the exam paper and not after the exam oral explanation and clarification. Write down one solution and one answer to each problem only. Read the problem statement carefully, think first, then act and answer what the problem is asking for.

Good luck!

Problem 1. (15 pts) The chlorine demand curve on the graph is obtained for a drinking water for a 1-hr contact time. Determine the daily amount of NaOCl to be applied to this water to produce a combined residual of 0.4 mg/L and a free residual of 0.5 mg/L after a contact time of 1 hr in a flow of 24,000 $m^3$/d.



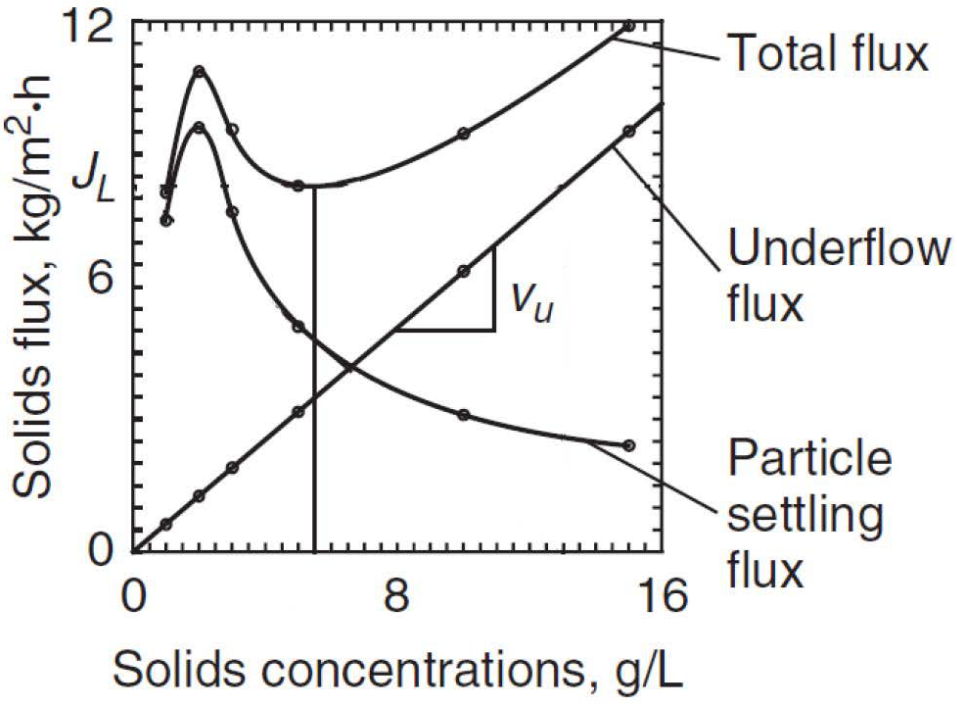

Problem 2. (10 pts) Calculate how long it would take to raise the oxygen concentration from 2 mg/L to 7 mg/L in a CMFR reactor if the transfer coefficient is 0.25/min and the Henry's Law coefficient is 769 L.atm/mol.

Problem 3. (20 pts) You are hired as a consultant for the water treatment plant, and you want to consider RO membrane for the salty water according to the following condition. (hint: assume that the following conditions apply to the module as a whole.)

- The membrane module is a spiral-wound module with a feed-concentrate channel height of 0.25 mm.
- The membrane surface area is 35 $m^2$. The module is 1 m long.
- The feed pressure is 30 bar and the permeate pressure is 1 bar.
- The influent flow rate is 12 $m^3$/hr.
- The water velocity in the feed-concentration channel is 0.381 m/s.
- The feed water contains 1,840 mg/L of $Na^+$ and 2,840 mg/L $Cl^-$. Other ions can be neglected.
- The groundwater is 13°C when it is extracted from the ground, but it goes through a heat exchanger that raises the temperature to 18°C before it reaches the RO membranes (to reduce the viscosity of the water).
- The water mass-transfer coefficient is $k_w$ = 2.6 L/($m^2$.bar.hr).
- The salt mass-transfer coefficient is $k_s$ = 0.75 L/($m^2$.hr).
- The osmotic coefficient is 0.95 for the feed water and 1.0 for the permeate.

Calculate the water and salt flux through the membrane module (permeate water sample contains 53.4 mg/L of NaCl).

Problem 4. (20 pts) Determine the area of a clarifier required for solids thickening for influent flowrate of 3,000 m3/h and solids concentration of 500 mg/L. The underflow solids concentration is set at 10,000 mg/L. The settling velocity of the sludge blanket follows the data plotted on figure. Also determine JL, CL, and Qu.




| Student | P.I. 1 | P.I. 2 | P.I. 3 | P.I. 4 | **Average** |
|---|---|---|---|---|---|
| #1 | 5 | 5 | 3 | 5 | **4.5** |
| #2 | 5 | 5 | 5 | 5 | **5** |
| #3 | 3 | 3 | 2 | 3 | **2.75** |

## CE 272: Geotechnical Modeling – Term Project

| **Term Project** | **CSU, Sacramento** |
|---|---|
| **CE 280C: Geotechnical Modeling** | **Spring 2016** |

**Grading:**

| | |
|---|---|
| Completion of individual components | 5% |
| Report | 30% |
| **Total** | **35%** |

**Details:**

The term project provides an opportunity to combine the multiple subjects learned in CE 280C and apply them to a specific problem. The problem chosen is to determine the anticipated lateral spreading response of a saturated homogeneous medium dense sand shaken with an earthquake. This problem will be investigated using previous centrifuge experiment results as well as modeled using the software program FLAC by Itasca. The results measured from the physical model will also be used to evaluate the capabilities of the numerical model developed.

Six different centrifuge facilities duplicated one liquefaction lateral spreading experiment in 2015. The centrifuge models consisted of a uniform deposit of Ottawa F-65 sand with a slope of around 5 degrees. The base of each model was shaken with multiple sinusoidal waves. The focus of the term project will be to analyze the data from two of the six facilities and to model these centrifuge tests numerically with the software program FLAC.

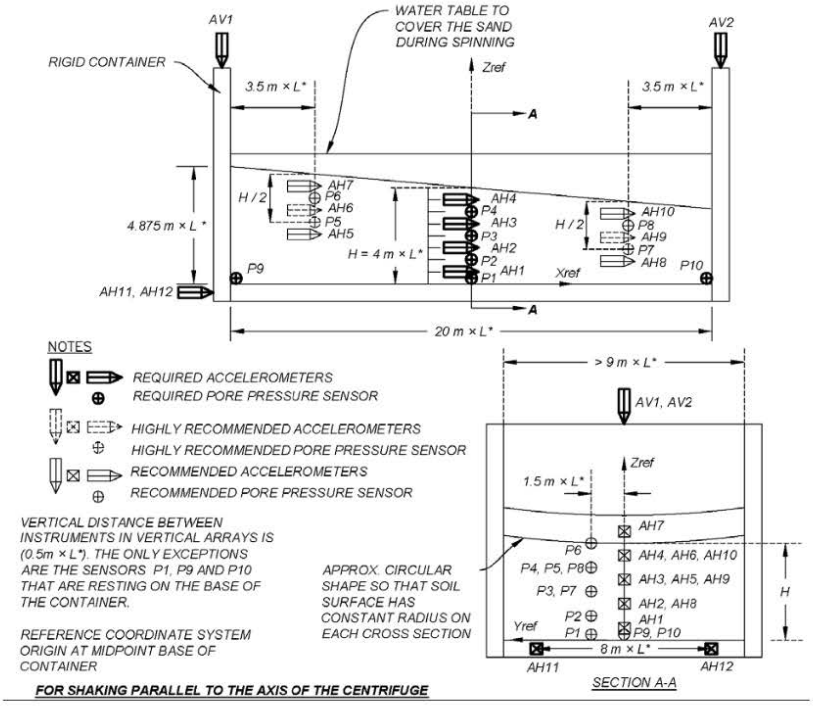
In addition to a final report that will be due on the last day of the semester, individual components of the term project will also be due throughout. Five out of the 35 points for the term project will be based on timely completion of these five components. One point will be given if the work is complete; otherwise, a 0 will be given.

| **Component** | **Due date** |
|---|---|
| 1. Evaluation of centrifuge data | February 3 |
| 2. Evaluation of Ottawa F-65 sand laboratory data | February 17 |
| 3. Calibration of PM4Sand model | March 16 |
| 4. Static analysis | April 13 |
| 5. Dynamic analysis | May 4 |
| **Term project due** | **May 11** |

1.

**Component 1: Evaluation of centrifuge data** (due February 3)

Raw data from one of the earthquake motions for the two centrifuge facilities is located in SacCT. Using this data, convert from model scale units to prototype scale units. The locations of the instruments are shown in the figure below. Accelerometers are labeled AH1, AH, etc.; pore water pressure transducers are labeled P1, P2, etc.; and displacement transducers are labeled DH1, DH2, etc. When presenting the centrifuge data, use units of g for acceleration, kPa for pore water pressure, and centimeters for displacement.




**Component 2: Evaluation of Ottawa F-65 sand laboratory data** (due February 17)

Data from a series of undrained cyclic triaxial tests conducted with the same Ottawa F-65 sand used in the centrifuge tests is posted in SacCT. For each triaxial test of Ottawa F-65 sand, plot the $CSR$ versus normal strain and $CSR$ versus mean effective stress. For each mean effective consolidation stress, plot $CSR$ versus the number of cycles to 95% excess pore water pressure ratio and determine the cyclic stress ratio to 15 cycles (term cyclic resistance ratio, $CRR$). Plot the $CRR$ versus mean effective consolidation stress. Estimate the $CRR$ for the Ottawa F-65 sand for a mean effective consolidation stress of 1 atm.

**Component 3: Calibration of PM4Sand model** (due March 16)

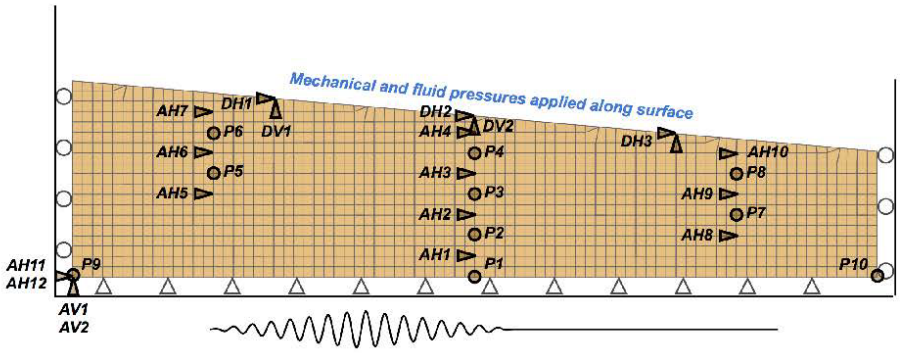
In addition to the cyclic strength characteristics in Component 2, the Ottawa F-65 sand also had the following properties:

| | |
|---|---|
| Relative density ($D_r$) | 65% |
| Permeability ($k$) | 1x10$^{-4}$ m/s |
| Unit weight ($\gamma$) | 19.6 kN/m$^3$ |

In the numerical analysis of the centrifuge tests, the PM4Sand model will be used to model the increase in excess pore water pressure and the associated loss of strength and increased strain. The key parameters that need to be selected for this constitutive model are $D_r$, $G_0$, and $h_{p0}$. Using these general index properties and those from Component 2, select the values of these internal properties. Compare the $CSR$ versus number of cycles to liquefaction from PM4Sand to that measured. Also compare the stress-strain and stress-path response of PM4Sand to one of the cyclic undrained triaxial tests conducted on the Ottawa F-65 sand.

**Component 4: Static analysis** (due April 13)

Using the software program FLAC, model in prototype units the slope tested in the centrifuge tests. When developing the mesh, there is a limit of 600 elements (consider 12 rows and 48 columns) using this demo version of FLAC. Use the elastic model available in FLAC for this stage of the analysis. Plot the distribution of effective horizontal and vertical normal stress, shear stress, and the ratio of the effective normal horizontal stress and effective vertical normal stress. The numerical mesh used to model the centrifuge tests (instrument locations and boundary locations included) should look similar to the one below.




**Component 5: Dynamic analysis** (due May 4)

With the mesh developed and stresses calculated in Component 4, convert the elements to the PM4Sand model with the properties selected in Component 3. Now shake the base of the model with motion 2 recorded at the base of the two centrifuges and calculate the acceleration, pore water pressure, and displacement during time at similar locations to those measured.

**Term project report** (due May 11)

Write a 10-page report (1.5 line spacing, 0.75" top/bottom margin, 1" side left/right margin) that summarizes the key findings from Components 1 through 5. Also submit electronically all completed files for the FLAC analyses.

**MS in Civil Engineering Program**
**Department of Civil Engineering**
**California State University Sacramento**

External review report
Virtual visit – 02/21/2023 to 02/22/2023

## Summary of visit:

The MS in Civil Engineering program at Cal State Sacramento is a robust program that offers a range of specializations, including Environmental, Geotechnical, Structural, Transportation, and Water Resources engineering. The program currently has 55 students enrolled, with an average graduation time of 2.5 to 3 years. The program is supported by 13 full-time faculty, as well as experienced industry professionals who teach some of the graduate courses.

During the program review, an external reviewer team met with various stakeholders, including students, faculty, the department chair, and the college dean. Through the self-study report and these interactions, the review team gained a comprehensive understanding of the program. The program constituents are dedicated to maintaining and improving the program, which has a solid foundation.

In the following sections, we highlight some of the program's key strengths and provide recommendations to further enhance the program's impact on students. These recommendations are based on the feedback collected by the review team and aim to help the program continue to improve and excel.

## Strengths

The review team identified several notable strengths of the MS in Civil Engineering program, including:

- The program offers a range of specializations or emphases that enable students to tailor their education to their career goals.
- The program is designed to accommodate students from non-civil engineering backgrounds, provided they complete the necessary prerequisite courses.
- The faculty are dedicated to student success, ensuring that students receive a high-quality education.
- The department has a strong and active industry advisory board that supports the program's success. The program has established strong relationships with industry partners, which has helped the department upgrade its laboratory, create dedicated funds for maintenance and upgrades, and provide students with valuable networking and career opportunities.

- The college has established policies such as supervision course credits and Research Assistantship Fellowship programs that support student-faculty research in the graduate program.
- The flexible class schedule, including early morning and late evening classes, is well-received by students who are mostly working professionals.
- The department has an excellent recruitment plan for the next three years, which will allow the program to further enhance the student experience.
- The department has also re-established a department assessment committee that was charged with creating assessment rubrics for assessing the student learning outcomes. This is a good first step in the right direction, as assessment is a collective effort of the faculty and an evolving process.
- The program is exploring the possibility of a blended degree program to attract more students from their established undergraduate program.

**Recommendations**

The following recommendations are suggested to further strengthen the overall success of the MS in Civil Engineering (MSCE) program:

- The program may consider restructuring its course offerings to have common themed courses that can be taken by students from multiple emphases. This may allow for more flexibility in class offerings and better serve the needs of students.
- It is suggested that the program curriculum be updated and demonstrate compliance with CSU Executive Order 1071. For a program such as civil engineering with several sub-disciplines, compliance can be achieved by demonstrating that more than fifty percent of learning outcomes are common among all sub-disciplines.
- Interviews with the program students revealed the need for more opportunities for students to learn more about the department's faculty experience and research interests. The department should consider offering information sessions where new graduate students can meet with all faculty advisors and develop a professional network to avoid confusion in the process of assigning faculty advisors.
- The department should expand its outreach efforts to recruit potential graduate students for the program and increase the visibility of the program in the region.
- The program should assess the needs of students and explore the possibility of offering hybrid/online courses if there is a demand for them among the students in the program.
- The program should consider re-wording some of its Student Learning Objectives (SLOs) to match the rigor of the MSCE graduate program.
- The program should consider adjusting its Program Learning Objectives (PLOs) to align with the aspirational goals that students achieve after a few years of graduation. The industry advisory board could be a valuable resource in improving the PLOs.

- The MSCE program's first comprehensive assessment is an important milestone, and it presents an opportunity to reflect on the program's strengths and areas for improvement. However, it is important to have a plan for how to make use of the assessment data to continuously improve the program. Therefore, it is recommended that the program collectively develops an improvement action plan.

By implementing these recommendations, the program can further enhance its strengths, providing students with an even better educational experience and preparing them for successful careers in the civil engineering field.

**Review Team members:**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# Internal Review Report

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| Internal Review Report: | Civil Engineering |
| College: | College of Engineering & Computer Science |
| Degree Programs: | **MS in Civil Engineering** |
| Internal Reviewers: | Ben Amata, Library<br>Pooria Assadi, College of Business |
| Date Submitted: | April 26, 2023 |

## I. Context:

The Department of Civil Engineering submitted a 65-page Self-Study in December 2022 that conformed structurally to the Self-Study requirements in the *Academic Program Review Guide* (referred to as the *Guide*). It was timely, complete, comprehensive and self-reflective. There was plenty evidence to support Department claims in its text and illustrations. Furthermore, a strength of the Self-Study was its reflection and the ability of the Department to identify weaknesses it needs to address. ***The IRs concluded that the Self-Study was exceptionally well done and can serve as a model not only for graduate but also undergraduate program review self-studies in its College and for other colleges and departments.***

The External Reviewers provided 10 commendations and 8 recommendations. Their evaluation was less about weaknesses and more about offering ways for improving an already strong degree program. They concluded: "By implementing these recommendations, the program can further enhance its strengths, providing students with an even better educational experience and preparing them for successful careers in the civil engineering field." Unfortunately, the IRs found that the report's bullet point approach didn't furnish the useful discussion and nuances of programmatic issues as well as an expository treatment would because the bullet point approach distills recommendations to the briefest and minimalist conveyance of information.

The External Reviewers (ERs) were Yasser S. Salem, Professor and Chair Civil Engineering California State Polytechnic, Pomona and Phoolendra Mishra, Ph.D. Professor and Chair Civil & Environmental Engineering California State University, Fullerton.

According to the ER's report the scheduled visit on Zoom was on February 21-22, 2023 conformed to the *Guide's* requirements.

## II. Recommendations:

### A. To Maintain Success

The IRs commend the various Departmental outreach efforts in the region as they relate to the overall success of the Department's mission. For instance, the Department has 8 student chapters that are

linked with various professional engineering organizations and invite speakers and participate in conferences and other activities in the region. The Department also has 6 laboratories along with robust fundraising programs for updating the lab equipment that allows it to sustain "some of the best civil engineering labs in Northern California region and directly benefit graduate students in pursuing research in their fields of interest." The Department has an opportunity in their Self-Study to provide a more in-depth explanation on how it might utilize these outreach efforts in their student recruitment efforts. This would also address one of ERs' recommendation that "The department should expand its outreach efforts to recruit potential graduate students for the program and increase the visibility of the program in the region."

In their Self-Study, the Department noted that "The onset of the COVID-19 pandemic did have a significant impact on enrollment, especially within the international student population who could not travel to the United States of attend online school. The Department is optimistic that once the economic performance and the job market changes, the graduate program will observe a rise in admissions as observed in past trends especially during the 2008 economic recession." At the same time, the Department highlights that "All courses are delivered in person, except for the necessary distance learning during the recent past because of the COVID-19 pandemic. Some courses have supplemental instruction online, but there are no dedicated on-line courses in the program." There is an opportunity for the Department to reflect on how they might utilize online or hybrid offerings to meet the realities of graduate education post the COVID-19 pandemic. This would be in keeping with ER's recommendation that "The program should assess the needs of students and explore the possibility of offering hybrid/online courses if there is a demand for them among the students in the program."

***Recommendation R.A.1: The IRs recommend that the Department analyze and take advantage of potential student recruitment opportunities in their existing outreach efforts in the region.***

***Recommendation R.A.2: The IRs recommend that the Department consider student demand for online or hybrid offerings to further foster students' success.***

## B. To Improve Student Learning (consider university/college goals on learning, research/scholarship, diversity)

The Department is doing very well with its assessment of SLOs and PLOs. The Self-Study furnished a comprehensive review of SLO/PLO assessment utilizing direct and indirect measures with an emphasis on the former. The ER's report didn't address learning outcomes, except for recommending an additional aspirational goal and re-wording some of its SLOs to match the rigor of the program.

The IRs noted in particular that the faculty have addressed SLO2 oral communication skills: Communicate effectively about technically complex engineering problems. Faculty utilizing a rubric evaluate student's CE 500 Culminating presentations. Since the program has small enrollment, the faculty could enhance their evaluation by video recording student presentations which would allow the presenters and other students to assess the presentations. If this isn't possible, having written evaluations would be an alternative method that would still provide for valuable feedback and assessment data. In order to provide longitudinal data, the Department could do this for other courses also. Oral communication evaluation has been a long-standing weakness in assessment at the University.

IRs suggest that the faculty consider conducting a literature review to determine if there are information/strategies on improving student's understanding of social science, legal, or interdisciplinary, research methodologies and techniques to assist students in researching the discipline's social aspects. The Engineering librarian could assist the Department in this effort.

The IRs disagree with the ER's recommendation: "The program should consider adjusting its Program Learning Objectives (PLOs) to align with the aspirational goals that students achieve after a few years of graduation. The industry advisory board could be a valuable resource in improving the PLOs." As the Department noted (SS p 36) that it already has an effective advisory board for offering program quality advice: "The purpose of these committees is to advise and guide the Department on all matters pertaining to the quality of both the undergraduate and graduate programs." The IRs judge that the faculty can better use their limited, precious program time for assessing learning that they have direct control over rather than aspirational post-graduation goals.

***Commendation: B.C.1: IRs concluded that the Department created a robust comprehensive assessment program for PLOs/SLOs that included a rich mixture of direct/indirect measures, employed rubrics, utilized an assessment Committee to evaluate their assessment program, and developed a 5-year assessment plan.***

***Commendation: B.C.2: IRs concluded that when discussing assessment results the Department reflected on student performance and when they didn't meet expectations, it suggested ways in which it potentially correct.***

***Recommendation: B.R.1: IRs recommend the Department explore enhancing assessment of oral presentation skills with other direct measures to combine with indirect ones.***

## C. To Improve Student Success (consider university/college goals on recruitment, retention, graduation, diversity, engagement)

The Department stated that it periodically reviews issues and topics to improve student learning and maintain the quality and integrity of their graduate degree. They initiated several programmatic changes for enrollment, curricular, and advising/orientations.

For enrollment, the ERs recommended: "The department should expand its outreach efforts to recruit potential graduate students for the program and increase the visibility of the program in the region." The IRs found this recommendation to be too broad to be of any help to the faculty. According to the Bureau of Labor Statistics in 2021, there are 5,090 employed civil engineers in the Sacramento--Roseville--Arden-Arcade area. The IRs recommend the Department explore ways to communicate and market its graduate program. Also, reviewing disciplinary literature and surveying others (CSUs, professional associations, etc.) might identify successful strategies.

The Department wrote that is has included reviewing GRE scores as part of a holistic approach to admissions, and it is too early to conclude its efficacy but they will review. It renumbered their courses that resulted in making it easier for students to identify courses in their respective specialized areas and assisted with advising students for their academic plan. If the Department hasn't considered an open house to increase enrollment, it could try it. the Physics Department doesn't have a graduate program,

but Ed Mills, VP Student Services, suggested it, and it substantially increased their enrollment. The Department can experiment with it. Given that the majority of students are full-time professionals, coming to the campus for advising/office hours is a challenge. The Graduate Coordinator developed a dedicated Canvas course, "CE Graduate Program Resources and Guide." It contains a step-by-step guide to navigate the various aspects of the civil engineering graduate program with details and tutorials on how to fill various forms, prepare for advancement to candidacy, and culminating experience, besides regular advising. Additionally, it contains faculty profiles, office hours, and other important information. Graduate students found this one central easily accessible place for information useful. The Graduate Coordinator organized orientation sessions for new incoming graduate students in order to introduce them to the program and help them familiarize with the Department and various resources available.

The ERs didn't address under-represented minorities (race/ethnicity and women students). The national average for women in civil engineering receiving master's degrees is 34%. The program averaged just slightly under with its enrollment of 31%. Below is the latest national data for 2018. Pertaining to race/ethnicity, the Department provides greater refinement, and its enrollment is near national averages except for whites which is substantially below, but the IRs don't view this as a problem.

| National Avg. (2018) | # | % |
|---|---|---|
| African-American | 111 | .03 |
| Asian | 372 | 11 |
| Hispanic/Latinx | 367 | 11 |
| Native American | 2 | .0006 |
| Other | 262 | .08 |
| White | 2014 | 64 |

https://ncsesdata.nsf.gov/sere/2018/ race

| CSUS CE 2018 | # | % | 2022 # | % |
|---|---|---|---|---|
| African-American | 3 | .04 | 2 | .02 |
| Asian | 15 | .22 | 6 | .08 |
| Foreign | 4 | .05 | 4 | .05 |
| Latino | 10 | .14 | 6 | .08 |
| Multi | 2 | .02 | 3 | .04 |
| Pacific-Islander | 1 | .01 | 0 | 0 |
| Native American | 0 | 0 | 0 | 0 |
| Unreported | 7 | .10 | 3 | .04 |
| White | 25 | .37 | 15 | .22 |

The IRs concluded the Department has been successful in meeting the University's, College, and faculty's gender and racial/diversity enrollment goals.

***Commendation: C.C.1: IRs commend the Department's efforts in enrollment, course renumbering, and its innovative approach to providing a CANVAS course with critical/essential information for its students.***

***Commendation: C.C.2: IRs commend the Department's efforts in its enrollment of under-represented minorities.***

***Recommendation: C.R.1: IRs recommend the faculty consider an open house if it hasn't already tried one (in-person and/or virtually) to determine if it can increase enrollment.***

***Recommendation C.R.2: The IRs recommend that the Department conduct a literature review and/or survey colleagues to determine if there are strategies it can possibly employ to increase women and racial/ethnic enrollment.***

## D. To Build Partnerships and Resource Development to Enhance the Student Experience (consider university/college goals on university as place, university experience, community engagement)

The Department highlighted various strategies for maintaining and enhancing the student experience including changes and enhancement to the program such as: curricular changes and improvements, student orientation and advising, faculty hiring, and laboratory development and enhancements.

The ERS specifically noted that "Interviews with the program students revealed the need for more opportunities for students to learn more about the department's faculty experience and research interests. The department should consider offering information sessions where new graduate students can meet with all faculty advisors and develop a professional network to avoid confusion in the process of assigning faculty advisors."

In light of the Departments avowed purpose of improving "student orientation and advising" and the ERs recommendation, the IRs concur that more explicit opportunities for the students to connect with both their full-time tenured/tenure-track faculty with research expertise as well as part-time faculty "from the industry with expertise in various subjects" and "useful real-world perspective" can significantly enhance students' experience.

***Recommendation R. D.1: The IR recommends the Department consider more explicit opportunities for the students to link with full-time and part-time faculty to improve their research and field knowledge.***

## E. To Improve Strategic and Budget Planning and Operational Effectiveness and to Ensure Sustainability (consider university/college goals on innovative teaching, scholarship, research, university as place, university experience)

As indicated previously, the Self-Study documented several strategies for maintaining and enhancing the program quality including changes and enhancement to the program (curricular changes and improvements, student orientation and advising, faculty hiring, and laboratory development and enhancements), industry advisory committees, and future assessment plan and activities. While the department mentioned its plans for full-time faculty hiring, it is relatively quiet on its plans for part-time faculty as well as any teaching assistants/graders. A more in-depth reflection and assessment of the needs in these domains would improve the Department's Self-Study for its goal of sustainable improvement, in particular in the area of teaching, over time.

In addition, the Department noted that "the structural engineering area has traditionally seen the greatest number of graduate students in the Department in the past." It is unclear why the proposed targets for number of faculty in this area remain stagnant during 2021-2024, and one less than 2020-2021. A bit more clarity in this domain would enhance the quality of the Self-Study.

***Recommendation R.E.1: The IRs recommend that Department develop a plan that includes academic personnel hiring needs that incorporates full-time and part-time faculty as well as any teaching assistants/graders, in keeping with the current and projected number of graduate students in each area.***

**MOU/Action Plan**

**Department of Civil Engineering**

**College of Engineering and Computer Science**

**California State University Sacramento**

Program: MS in Civil Engineering

College: College of Engineering and Computer Science

Date: 06/15/2023 **Program Review**

| **Program Review Finding**<br><br>Cite self-study, external review, internal review, and/or accreditation documentation | **2 YR**<br><br>List goal, success indicator, responsible parties, and resource implications. | **4 YR**<br><br>List goal, success indicator, responsible parties, and resource implications. | **6 YR**<br><br>List goal, success indicator, responsible parties, and resource implications. |
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| **To Maintain Success** | | | |
| ***Recommendation R.A.1: The IRs recommend that the Department analyze and take advantage of potential student recruitment opportunities in their existing outreach efforts in the region.*** | Develop dedicated webpages for active student chapters (clubs) in the Dept. to catalog and highlight club activities, student participation, and other information. These pages will be linked to list of active clubs webpage on the College of ECS website.<br><br>Develop a dedicated webpage on CE Dept. website for each laboratory, listing highlights and features of each lab, associated faculty with each lab and their area of expertise, and sample list of projects faculty are engaged in utilizing the labs along with participating students. | | |

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| | The abovementioned information can also be tied into the CE Dept. "Graduate Student Resources and Guide" canvas course, and used during information sessions and webinars to attract perspective students.<br><br>Distribute promotional materials for the graduate program and any info sessions regarding the graduate program at events like the golf tournament and the Ken Kerry Endowment luncheon.<br><br>The Dept. will continue to monitor incoming student numbers and ways to assess the impact of recruitment efforts by comparing past, present, and future admissions data. | | |
| ***Recommendation R.A.2: The IRs recommend that the Department consider student demand for online or hybrid offerings to further foster students' success.*** | The Dept. will develop a conduct a survey of perspective applicants from the civil engineering community in the Sacramento region and Northern California to obtain information on preferences in terms of program modality. The Dept. will also conduct internal discussions on the pros and cons associated with changing program modality from in-person to hybrid/online. | | |
| ***Self-Study pg. 37. Explore the feasibility of a blended undergraduate/graduate program to enhance access to the master's program for Sacramento State undergraduates*** | The Dept. will task the curriculum committee to explore the feasibility and structure of a blended program to promote seamless transition of undergraduate students into graduate program. Additionally, with the new chancellor's office policy allowing overlap in units between undergraduate and graduate degrees, this option would become more attractive to students to complete both their undergraduate and | Present details, structure, and respective forms to start the approval process of a blended BS/MS degree in civil engineering. The target date for program launch is Fall 2025. | Review the performance of the blended BS/MS program and consider changes, improvements, enhancements for further effectiveness. |

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| | graduate degrees in five years. | | |
| **To Improve Student Learning** (consider university/college goals on learning, research/scholarship, diversity) | | | |
| ***Self-Study pg. 37: Periodic Review of PLO in consultation with Industry Advisory Committees and CE Dept.*** | Review and approve PLO in consultation with Industry Advisory Committees and CE Dept. | Review and approve PLO in consultation with Industry Advisory Committees and CE Dept. | Review and approve PLO in consultation with Industry Advisory Committees and CE Dept. |
| ***Recommendation: B.R.1: IRs recommend the Department explore enhancing assessment of oral presentation skills with other direct measures to combine with indirect ones.*** | Develop a process to record CE 500 student presentations for participating students. Assign video recordings to all CE faculty to assess SLO 2 (communication). This would result in better sample size of faculty review and input in assessing this SLO. | Review and identify courses in each area of specialization outside of CE 500 to periodically collect data relevant to SLO 2 from such courses. Utilize the same rubric developed for CE 500 presentations. This would provide an opportunity for longitudinal data collection on this SLO. | Compare student progression on SLO 2 using data from prior courses and CE 500 presentations. |
| **To Improve Student Success** (consider university/college goals on recruitment, retention, graduation, diversity, engagement) | | | |
| ***Recommendation: C.R.1: IRs recommend the faculty consider an open house if it hasn't already tried one (in-person and/or virtually) to determine if it can increase enrollment.*** | Organize and in-person and online new graduate student orientation and graduate student reception to engage with faculty in the Dept. and learn more about peers and faculty work. | Continue to organize graduate student orientation and reception with revisions using student and faculty input. | Continue to organize graduate student orientation and reception with revisions using student and faculty input. |

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| ***Recommendation C.R.2: The IRs recommend that the Department conduct a literature review and/or survey colleagues to determine if there are strategies it can possibly employ to increase women and racial/ethnic enrollment.*** | Develop a survey as recommended with relevant questions related to increasing enrollment in underrepresented student body.<br><br>Develop a presentation about engineering graduate education to present at meetings of the campus chapters of groups such as the Society of Women Engineers and the Society of Hispanic Professional Engineers. | Conduct survey and analyze the input to develop and implement specific strategies<br><br>Present about civil engineering graduate education at meetings of campus chapters of groups such as the Society of Women Engineers and the Society of Hispanic Professional Engineers. | Review the impact of specific strategies on enrollment diversification. |
| **To Build Partnerships and Resource Development to Enhance the Student Experience** (consider university/college goals on university as place, university experience, community engagement) | | | |
| ***Recommendation R. D.1: The IR recommends the Department consider more explicit opportunities for the students to link with full-time and part-time faculty to improve their research and field knowledge.*** | Organize and in-person and online new graduate student orientation and graduate student reception to engage with faculty in the Dept. and learn more about peers and faculty work. | Continue to organize graduate student orientation and reception with revisions using student and faculty input. | Continue to organize graduate student orientation and reception with revisions using student and faculty input. |
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| **To Improve Strategic & Budget and Operational Effectiveness and to Insure Sustainability** (consider university/college goals on innovative teaching, scholarship, research, university as place, university experience) | | | |

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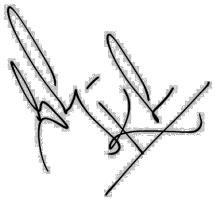
| ***Recommendation R.E.1: The IRs recommend that Department develop a plan that includes academic personnel hiring needs that incorporates full-time and part-time faculty as well as any teaching assistants/graders, in keeping with the current and projected number of graduate students in each area.*** | The current 2021-2024 strategic hiring plan approved by the Dept. will be reviewed and revised at the Fall 2023 retreat for the next few years. | Review and revise strategic hiring plan for the next period. | Review and revise strategic hiring plan for the next period. |

**Department Chair Name/Signature: Ghazan Khan**



**College Dean Name/Signature: Kevan Shafizadeh**