# Academic Program Review
# MS Computer Engineering

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


The Academic Program Review Committee (APRC) affirms that the Departments of Computer Engineering and Electrical and Electronic Engineering have completed program review as per policy, including self-study, external review, internal review, and action plan submission for the MS Electrical and Electronic 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

# Computer Engineering (CPE) Self Study
# Fall 2022

Sacramento State University

Review 2022-23

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## Element One: Mission and Context

### A. University, college, and academic unit missions

University mission: 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.

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

CPE Program mission: The Master of Science degree in Computer Engineering is designed to provide opportunities for students with undergraduate degrees in Computer Engineering, Computer Science, Electrical Engineering, or a closely related field to pursue graduate studies in this interdisciplinary field. The program provides students with broad and advanced knowledge in areas such as advanced microprocessor architecture, parallel computer architecture, advanced microprocessor systems, distributed computing, data communication, computer networks, operating systems, and concurrent programming.

### B. Degrees offered, with link to the University Catalog

M.S. in Computer Engineering

https://catalog.csus.edu/colleges/engineering-computer-science/engineering-computer-engineering/ms-in-computer-engineering/

### C. Minors offered, with link to the University Catalog

There are no minor specializations.

### D. Service to or from other departments, degree programs, and/or general education

Computer Engineering program: This degree is offered through a joint program sponsored by the Computer Science Department and the Electrical & Electronic Engineering Department. This arrangement has the advantage of support from two strong departments.

### E. External educational partnerships

Since CPE program is jointly sponsored by EEE and CSC department, CPE program is involved in the external educational partnerships from both departments.

- IEEE (Institute of Electrical and Electronics Engineers) (Institute of Electrical and Electronics Engineers) (Institute of Electrical and Electronic Engineers) is the largest technical society in the world. The IEEE Sacramento Valley section has active participation by faculty in our Program: https://r6.ieee.org/sacramento/. The IEEE Sacramento Valley section also supports many society chapters that relate to the technical areas within Computer Engineering:
    - IEEE Vehicular Technology/Communications Society
    - IEEE Computer Society

IEEE student members (undergraduate and graduate) also maintain an active IEEE Sacramento State Student Branch: https://www.instagram.com/csus.ieee/. The IEEE Student Branch conducts several technical and social events that benefit our students; examples are invited talks from people in industry such as Chevron, PG&E, resume workshops, Evening with industry.

We have several educational partnerships with local industries like Intel, SMUD, and PG&E.

In addition, we also partner up with local community colleges to transfer students to the program; reach out to local high schools for attracting high school students; team with San Francisco State, San Jose State, and Sonoma State for the "CSForAll" initiative, which builds a consortium of Northern California CSUs to support the professional development of local K-12 computer science teachers; and train local high school teachers in the areas of Cybersecurity as a certificate granting institution within the National Cybersecurity Teaching Academy (NCTA).

F. Major structural changes in academic unit since last review (new, moved, or discontinued degrees,

concentrations, minors, etc.)

The CPE 201: Research Methodology is the seminar course that is required for all incoming graduate students in the first semester. The main function of the course is to train students in writing, conducting effective research and assisting them to decide on specialization choices. Since Fall 2021, it has been updated to 2 units of credit (from the initial 1 unit of credit), to satisfy the university requirement as a GWI (Graduate Writing Intensive) course.

Comparing to the 2012-2014 Catalog (https://oldcatalog.csus.edu/12-14/programs/cpe.html#Master), CPE 280 Advanced Computer Architecture and EEE 285 Micro-Computer System Design I were removed from the category of Required Core Courses and added into the Required Breath Courses. EEE 270 Advanced Topics in Logic Design 2 was added into the category of Required Core Courses.

The Required Breath Courses now added 2 more categories, Algorithms and applications, Microelectric design. The other 3 categories (architecture, network and software) were changed to Computer architecture and digital design, Networks and security, Systems software. The Required Breath Courses now include new courses such as CSC 250 Computer Security , CSC 253 Computer Forensics, and CSC 254 Network Security.

## Element Two: Learning Outcomes and Assessment
### A. List program learning outcomes

The CPE Graduate Program PLOs are as follows:
1. Problem Solving: Graduates apply knowledge from their undergraduate and graduate computer engineering studies and related disciplines to solve complex computer engineering problems that require advanced knowledge within the field.
2. Critical thinking: Graduates understand and integrate new knowledge within the field.
3. Creative thinking: Graduates can plan and conduct projects on advanced topics within the field.
4. Written communication: Graduates can report on advanced topics within the field.

5. Integrative and applied learning: Graduates can work as a team in a diverse changing world.
6. Civic knowledge and engagement: Gradates recognize the ethical standards, and possess skills for effective communication.
The table below shows the mapping of between CPE MS Program Learning Outcomes to the Institutional Graduate Learning Goals.

**Table 1: Mapping between CPE MS Program Learning Outcomes to the Institutional Graduate Learning Goals**

| CPE Program Learning Outcomes | Institutional Graduate Learning Goals for Masters Programs | | | | | |
|---|---|---|---|---|---|---|
| | 1.Disciplinary knowledge | 2.Communication | 3.Critical thinking/analysis | 4.Information literacy | 5.Professionalism | 6.Intercultural/Global Perspectives |
| 1.Problem Solving | X | | | | | |
| 2.Critical thinking | | | X | X | | |
| 3.Creative thinking | | | X | | | |
| 4.Written communication | | X | | | | |
| 5.Integrative and applied learning | | | | X | | X |
| 6.Civic knowledge and engagement | | X | | | X | X |

The CpE MS degree curriculum includes CpE, CSc, and EEE courses that are taught by faculty members from the CSc and EEE departments. The assessment of the CpE MS program relies on the assessment data received from the two departments where each uses its own PLOs. The EEE and CSC PLOs are all mapped to the institutional Graduate Learning Goals on a one-to-one correspondence.

Therefore, to better align the CPE PLOs with the Institutional PLOs and better map the CPE PLOs to the CSc and EEE PLOs, the following CPE Graduate Program PLOs are proposed. These new PLOs was already approved by the Computer Engineering Program Committee and will get further feedback and review from the Industry advisory council of CPE.

**The proposed CPE Graduate Program PLOs:**

1. Master, integrate, and apply advanced knowledge and skills to solve complex computer engineering problems. (Disciplinary Knowledge)
2. Communicate research findings, original work, technical and non-technical support materials in writing and via oral presentation to a variety of audiences. (Communication)
3. Demonstrate the ability to be creative and analytical, and to contribute to the field of computer engineering. (Critical Thinking/ Analysis)

4. Demonstrate the ability to obtain, assess, and analyze developments and advancements in computer engineering from discipline specific databases and information sources. (Information Literacy)
5. Adhere to ethical standards of the profession when conducting academic and professional activities. (Professionalism)
6. Apply intercultural and/or global perspectives to solve problems, inform research, and make contributions to the field. (Intercultural/ Global Perspectives)

## B. Summary of data for each learning outcome.

The data presented in this section are based on the assessment towards proposed CPE Graduate Program PLOs, which align with the institutional Graduate Learning Goals on a one-to-one correspondence.

In each of the tables 2-6 below, the data is organized as Above or equal expectation percentage.

- Learning Outcome 1: Overall disciplinary data is assessed in the Culminating experience: Plan C Comprehensive exam, in which students are tested on their knowledge and command of courses in the CPE Graduate Program. The Comprehensive exam is conducted twice a year (March and October). The past 10-year success rate in the exam (percentage of students with passing score of 70% or higher) is shown below in Figure 1.
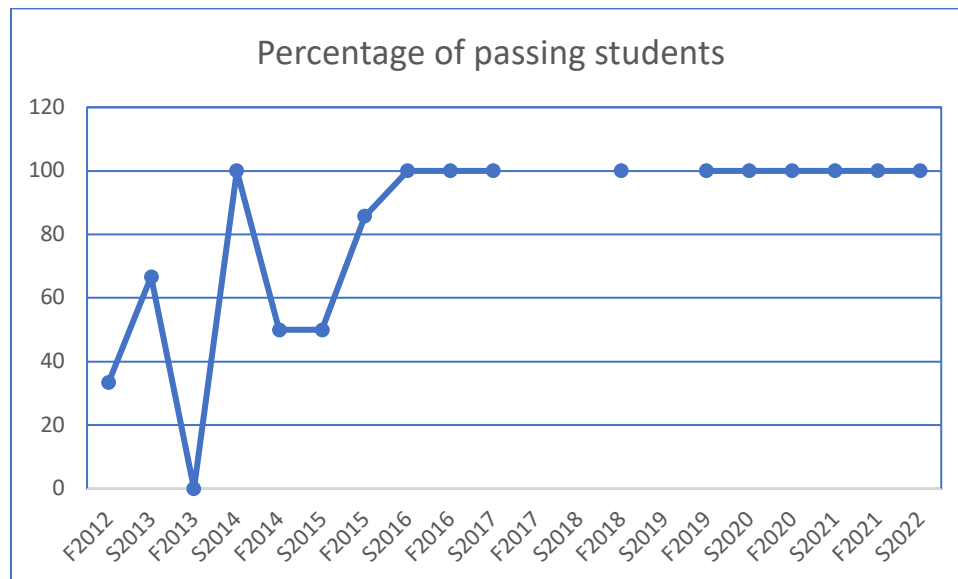


Figure 1. Percentage of passing students in Plan C Comprehensive Exams

- Learning Outcome 2: Communication is assessed in the mandatory courses (from projects) that are required to be taken by all students in the program. The assessment is done based on evaluation of the project reports and checking if all the components of the reports, such as referencing, formatting and content are satisfactory. Table 2 shows the percentage of students who meet or exceed the expectation.

**Table 2: Mandatory course project data**

| Course | 2020/2021 | 2021/2022 |
|---|---|---|
| CPE 201 Research Methodology | 100% | 60% |

- Learning Outcome 3: Critical Thinking is also assessed in the Culminating experience: Plan C Comprehensive exams. Please refer to Figure 1 for the past 10-year success rate in the exams (percentage of students with passing score of 70% or higher).

- Learning Outcome 4: Information Literacy is assessed in the introductory seminar course: CPE 201: Research Methodology (from reference collection), whose aim is to train students in writing and research planning. This assessment is done based on evaluation of reference lists created by students in their preferred specialization area and checking if components of the references, such as inclusion of all details and relevance, are satisfactory.

**Table 3: Mandatory course reference collection data**

| Course | 2020/2021 | 2021/2022 |
|---|---|---|
| CPE 201 Research Methodology | 100% | 80% |

- Learning Outcome 5: Professionalism, like PLO 4, is also assessed in the introductory seminar course: CPE 201: Research Methodology (from project writing match). This assessment is done based on evaluation of the degree of match between student project reports and online sources, as obtained from use of the Turnitin© software.

**Table 4: Mandatory course project writing match data**

| Course | 2020/2021 | 2021/2022 |
|---|---|---|
| CPE 201: Research Methodology | 50% | 60% |

- Learning Outcome 6: Intercultural/Global Perspectives is assessed in the Culminating Experience (Thesis/Project) for all students (from topic global relevance).

**Table 5: Thesis/Project topic global relevance data**

| Course | 2020/2021 | 2021/2022 |
|---|---|---|
| CPE 500: Thesis/Project | 50% | 50% |

C. Analysis for each learning outcome, including how to maintain success and improve learning

- Learning Outcome 1: Disciplinary Knowledge

Figure 1 summarizes data for this outcome over the past ten years. This outcome is studied in the Plan C: Comprehensive exam, which is the alternative to the thesis/project option for CPE graduate

students. The passing rate in the exam over the past 10 years shows some fluctuation before Spring 2016 but maintains 100% since Spring 2016.

- Learning Outcome 2: Communication

Table 3 summarizes data for this outcome over the past two years. CPE 201: Research Methodology course is mandatory for all beginning first-semester CPE graduate students. The satisfactory percentage for the 2020/2021 year is 100%, while for the 2021/2022 year is 60%.

- Learning Outcome 3: Critical Thinking

Figure 1 summarizes data for this outcome over the past ten years. This outcome is studied in the Plan C: Comprehensive exam, which is the alternative to the thesis/project option for CPE graduate students. The passing rate in the exam over the past 10 years shows some fluctuation before Spring 2016 but maintains 100% since Spring 2016.

- Learning Outcome 4: Information Literacy

Table 5 summarizes data for this outcome over the past 2 years. Generally, the performance of students seems to be excellent, and students are able to access and list relevant reference sources satisfactorily.

- Learning Outcome 5: Professionalism

Table 6 summarizes data for this outcome over the past two years. It is of concern that 50 % or higher number of student reports are not reaching satisfactory levels of original content in writing. It is acceptable for students to access material for their reports from external sources, including the internet; however, further training is required to improve students' ability to appropriately reference and present material in their own words.

- Learning Outcome 6: Intercultural/Global Perspectives

Table 7 summarizes data for this outcome over the past two years. The percentages shown reflect the number of thesis/project topics that are directly relevant to global issues. While all graduate projects have some useful applications, examples of CPE project topics that have components of global relevance are research in image classification, security analysis of computer systems etc.

D. Other relevant data (student surveys, alumni, licensure passage rates, grad school acceptance, internships, etc.) and how the data is used to maintain success and improve learning.

- Alumni Survey

The following survey is prepared and will be sent to CPE graduate alumni to obtain their feedback on the extent to which our program enriched their work and career.

## Graduate Alumni Survey

Please complete the following questions, based on your experience as a graduate student in the CPE program at Sacramento State University.

**To what extent did the program help you develop the following knowledge or proficiencies:**

1. **Disciplinary Knowledge:** The ability to master, integrate, and apply advanced knowledge and skills to solve complex computer engineering problems.
2. **Communication**: The ability to effectively communicate research findings, original work, technical and non-technical support materials in writing and via oral presentation to a variety of audiences.
3. **Critical Thinking/ Analysis**: The ability to be creative and analytical, and to contribute to the field of computer engineering.
4. **Information Literacy**: The ability to obtain, assess, and analyze developments and advancements in computer engineering.
5. **Professionalism**: The ability to adhere to ethical standards of the profession when conducting professional activities.
6. **Intercultural/Global Perspectives**: The ability to understand the relevance and impact of CPE disciplinary knowledge in the wider societal and global contexts.
7. In your view, what are two strengths and two areas for improvement in the CPE Graduate program?

## E. Comprehensive assessment plan

The CpE MS degree curriculum includes CpE, CSc, and EEE courses that are taught by faculty members from the CSc and EEE departments. The assessment of the CpE program relies on the assessment data received from the two departments where each uses its own PLOs. The CPE PLOs align with the Institutional PLOs, and can be mapped correspondingly to the CSc and EEE PLOs.

Computer science graduate program PLOs are as follows:

1. Master, integrate, and apply advanced knowledge and skills to solve complex computer science problems. (Disciplinary Knowledge)
2. Communicate research findings, original work, technical and non-technical support materials in writing and via oral presentation to a variety of audiences. (Communication)
3. Demonstrate the ability to be creative and analytical, and to contribute to the field of computer science. (Critical Thinking/ Analysis)
4. Demonstrate the ability to obtain, assess, and analyze developments and advancements in computer science. (Information Literacy)
5. Adhere to ethical standards of the profession when conducting academic and professional activities. (Professionalism)
6. Apply intercultural and/or global perspectives to solve problems, inform research, and make contributions to the field. (Intercultural/ Global Perspectives)

The mapping between CSC and CPE PLOs is shown in Table 6 below:

**Table 6. The Mapping from Proposed CPE MS PLO to CSC PLO**

|           | CSC PLO 1 | CSC PLO 2 | CSC PLO 3 | CSC PLO 4 | CSC PLO 5 | CSC PLO 6 |
|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| CPE PLO 1 | x         |           |           |           |           |           |
| CPE PLO 2 |           | x         |           |           |           |           |
| CPE PLO 3 |           |           | x         |           |           |           |
| CPE PLO 4 |           |           |           | x         |           |           |
| CPE PLO 5 |           |           |           |           | x         |           |
| CPE PLO 6 |           |           |           |           |           | x         |

EEE Graduate PLOs are as follows:

1. Apply core and advanced Electrical and Electronic Engineering knowledge and skills to synthesize and analyze as a part of the design process. (Disciplinary Knowledge)
2. Effectively communicate the theory, function, and practical aspects of an electrical and/or electronic system. (Communication)
3. Apply contemporary engineering techniques and tools for analysis and design (Critical Thinking/ Analysis)
4. Organize relevant information needed to address engineering problems (Information Literacy)
5. Integrate/Propose/Employ timely and appropriate decisions in the engineering workplace (Professionalism)
6. Propose engineering solutions that would benefit global environment and society (Intercultural/ Global Perspectives)

The mapping between EEE and CPE PLOs is shown in the Table 7 below:

**Table 7. The Mapping from Proposed CPE MS PLO to EEE PLO**

|           | EEE PLO 1 | EEE PLO 2 | EEE PLO 3 | EEE PLO 4 | EEE PLO 5 | EEE PLO 6 |
|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| CPE PLO 1 | x         |           |           |           |           |           |
| CPE PLO 2 |           | x         |           |           |           |           |
| CPE PLO 3 |           |           | x         |           |           |           |
| CPE PLO 4 |           |           |           | x         |           |           |
| CPE PLO 5 |           |           |           |           | x         |           |
| CPE PLO 6 |           |           |           |           |           | x         |

Our PLOs are assessed in two ways: Course Level Assessment and Program Level Assessment.

Course Level Assessment (Direct Measurement)

Assignments and exams in individual courses provide immediate and valuable feedback to both the student and the faculty. Assignments, projects, and examinations including mid-terms and finals are used for assessment in the CPE/CSC/EEE courses. They allow the faculty to evaluate the students' learning effectiveness and identify any potential problems in related courses.

All CPE students are required to take 4 core courses:
- CPE 201 Research Methodology

- CSC/EEE 273 Hierarchical Digital Design Methodology
- CSC 205 Computer Systems Structure
- EEE 270 Advanced Topics in Logic Design

In addition, since computer engineering has different fields of specialization, students are required to cover at least two from the following five areas with equal number from CSC and EEE courses:

- ALGORITHMS AND APPLICATIONS
    - CSC 206 Algorithms And Paradigms
    - EEE 221 Machine Vision
    - EEE 225 Advanced Robot Control
    - EEE 244 Electrical Engineering Computational Methods and Applications
    - EEE 246 Advanced Digital Control
- COMPUTER ARCHITECTURE AND DIGITAL DESIGN
    - CSC 242 Computer-Aided Systems Design and Verification
    - EEE 272 High Speed Digital System Design
    - EEE 274 Advanced Timing Analysis
    - EEE/CSC 280 Advanced Computer Architecture
    - EEE 285 Micro-Computer System Design I
    - EEE 286 Microcomputer System Design II
- MICROELECTRIC DESIGN
    - EEE 230 Analog and Mixed Signal Integrated Circuit Design
    - EEE 231 Advanced Analog and Mixed Signal Integrated Circuit Design
    - EEE 232 Key Mixed-Signal Integrated Circuit Building Blocks
    - EEE 234 Digital Integrated Circuit Design 2
    - EEE 235 Mixed-Signal IC Design Laboratory
    - EEE 236 Advanced Semiconductor Devices
    - EEE 238 Advanced VLSI Design-For-Test I
    - EEE 239 Advanced VLSI Design-For-Test II
- NETWORKS AND SECURITY
    - CSC 250 Computer Security
    - CSC 253 Computer Forensics
    - CSC 254 Network Security
    - CSC 255 Computer Networks
- SYSTEMS SOFTWARE
    - CSC 151 Compiler Construction
    - CPE/CSC 159 Operating System Pragmatics 3,4
    - CSC 239 Advanced Operating Systems Principles and Design

Students will also need to take one additional CSC elective and one additional EEE elective from the above Required Breadth Courses or any 200-level CSC/EEE courses subject to meeting the required prerequisites.

Table 8 below maps the proposed PLOs to the Core and Elective core courses in the CPE Graduate Program:

**Table 8: Mapping of Proposed Learning Outcomes with program courses**

| | PLO 1 | PLO 2 | PLO 3 | PLO 4 | PLO 5 | PLO 6 |
|---|---|---|---|---|---|---|
| CpE 201 | | X | X | X | X | X |
| CSc 205 | X | | X | | | |
| CSc/EEE273 | X | | X | | | |
| EEE 270 | X | X | X | | | |
| CSc 151 | X | | X | X | | |
| CSc/CpE 159 | X | | X | X | | |
| CPe 190 | X | X | X | X | X | |
| CSc 206 | | | | | | X |
| CSc 239 | X | | X | | | |
| CSc 242 | X | | X | | | |
| CSc 250 | X | | X | | | |
| CSc 253 | X | | X | | | |
| CSC 254 | X | | X | | | |
| CSc 255 | X | X | X | X | | |
| CSc/EEE 280 | X | X | X | X | | |
| EEE 221 | X | X | X | X | | X |
| EEE 225 | X | X | X | X | | X |
| EEE 230 | X | | X | | | |
| EEE 231 | X | | X | | | |
| EEE 232 | X | | X | | | |
| EEE 234 | X | | X | | | |
| EEE 235 | | | X | | | |
| EEE 236 | X | | | | | |
| EEE 238 | X | | | | | |
| EEE 239 | X | | | | | |
| EEE 244 | | X | | | | |
| EEE 246 | X | X | X | X | | X |
| EEE 272 | X | | X | X | | |
| EEE 274 | X | | X | | | |
| EEE 285 | X | | X | X | | |
| EEE 286 | X | | X | X | | |
| CpE 500 | X | X | X | X | X | X |

Program Level Assessment (Indirect Measurement)

Outcomes assessment at the program level is carried out by using a variety of assessment tools:

o Student and alumni surveys reflecting on program outcomes.
o Feedback from CPE Industry Advisory Committee.
o Master student culminating experience (thesis/project) work

**Element Three: Student Success**

All data presented in this section was obtained from the CSUS ORIEP office:

https://www.csus.edu/president/institutional-research-effectiveness-planning/

A. Admission data disaggregated by gender and ethnicity for each degree.

- 2016-2022 Admission data for CPE M.S. program

**Table 9: CPE Graduate program: Admission numbers 2016-2021**

| Year | Fall 16 | Spr 17 | Fall 17 | Spr 18 | Fall 18 | Spr 19 | Fall 19 | Spr 20 | Fall 20 | Spr 21 | Fall 21 | Spr 22 | Fall 22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Students applied | 32 | 7 | 27 | 19 | 31 | 12 | 28 | 18 | 45 | 6 | 24 | 14 | 44 |
| Students admitted | 2 | 0 | 10 | 7 | 0 | 2 | 6 | 5 | 2 | 3 | 7 | 2 | 6 |

- A typical view of ethnicity and gender distribution is shown below in Figure 2 for Fall 2022 CPE M.S. admissions:

https://www.csus.edu/president/institutional-research-effectiveness-planning/dashboards/admissions.html
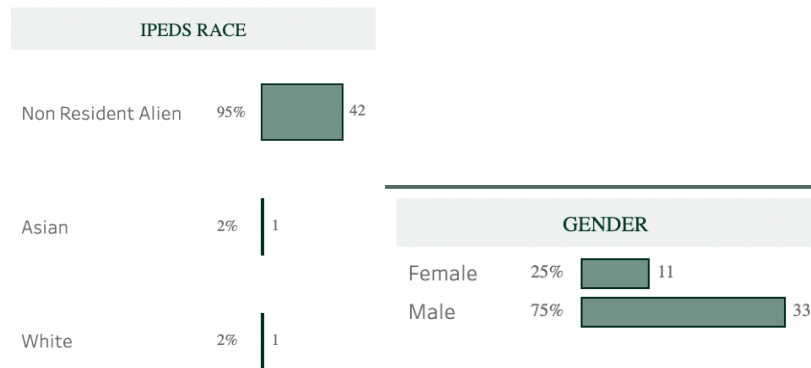


**Figure 2: Ethnicity and Gender distribution of CPE graduate program applicants – Fall 2022**

As seen above, a majority of our applicants (95%) are international, and the ethnicity distribution within international applicants is shown below in Figure 3:

**Non Resident Alien**
# of Applicants: **42**
Applicant %:     **95%**

**Race Specified**

| | | |
|---|---|---|
| Asian Indian | 66.6% | |
| Mexican | 9.6% | 187 |
| European | 3.2% | 63 |
| Chinese | 2.5% | 49 |
| Black | 2.4% | 46 |
| Other White | 2.3% | 45 |
| Vietnamese | 1.4% | 28 |
| Other Asian | 1.3% | 25 |
| Other Black | 1.2% | 23 |
| Bangladeshi | 1.0% | 20 |
| Burmese | 0.8% | 16 |
| Korean | 0.8% | 16 |
| Japanese | 0.7% | 14 |
| Nepalese | 0.7% | 14 |
| Taiwanese | 0.7% | 14 |
| Filipino | 0.7% | 13 |
| Other South American | 0.6% | 12 |
| Pakistani | 0.6% | 12 |
| Salvadoran | 0.6% | 12 |
| Guatemalan | 0.4% | 8 |
| Sri Lankan | 0.4% | 7 |
| Colombian | 0.3% | 6 |
| Honduran | 0.3% | 5 |
| Indigenous Mexican | 0.3% | 5 |
| Middle Easterner | 0.3% | 5 |

View is too large to show

**Figure 3: Ethnicity distribution of CPE graduate program international applicants – Fall 2022**

B. Retention data disaggregated by gender and ethnicity for each degree.

- 2016-2021 Enrollment data for CPE M.S. program

**Table 10: CPE Graduate program: Enrollment numbers 2016-2021**

| Year | Fall 16 | Spr 17 | Fall 17 | Spr 18 | Fall 18 | Spr 19 | Fall 19 | Spr 20 | Fall 20 | Spr 21 | Fall 21 | Spr 22 | Fall 22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Students enrolled | 16 | 10 | 6 | 9 | 7 | 8 | 11 | 11 | 12 | 12 | 9 | 4 | 7 |

- A typical view of ethnicity and gender distribution is shown below for Fall 2021 CPE M.S. enrollment:

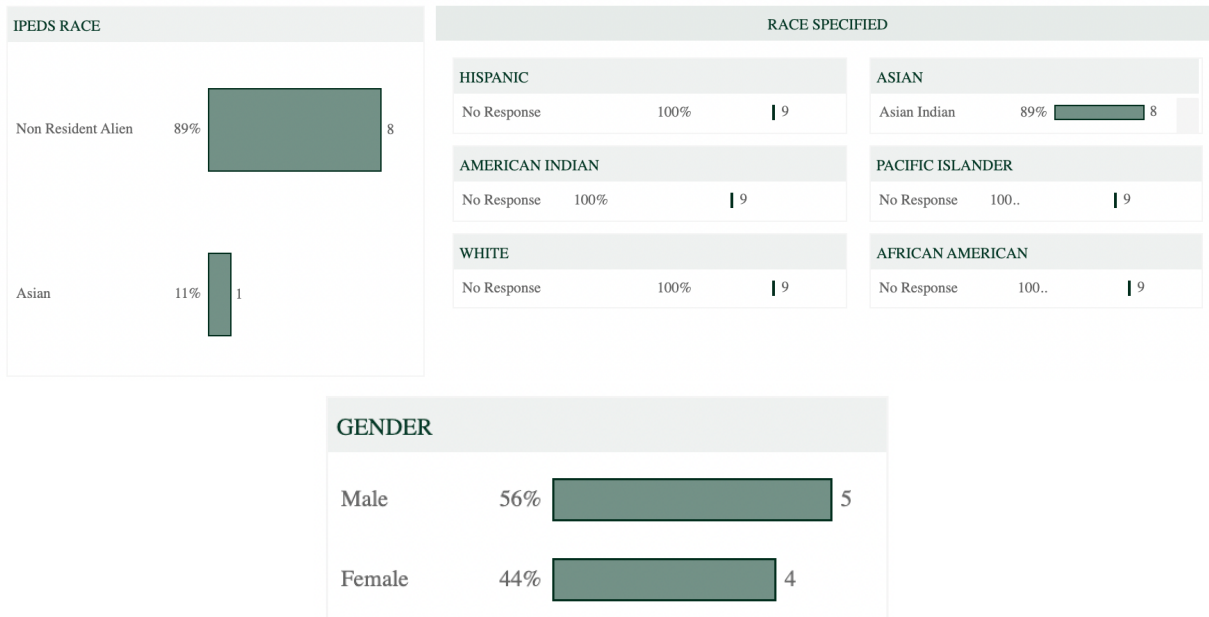https://www.csus.edu/president/institutional-research-effectiveness-planning/dashboards/enrollment.html





**Figure 4: Ethnicity and Gender distribution of CPE enrolled graduate students – Fall 2021**

The 10-year history of student headcount in the CPE graduate program is shown below in Figure 5. Student count reached a peak in 2014-2015. Retention numbers are not specifically provided by the university for graduate programs; however, from program records, it is almost 100%. Very rarely, a student might transition to a related department such as EEE or CSC with similar rare transfer from an external department to the CPE graduate program.
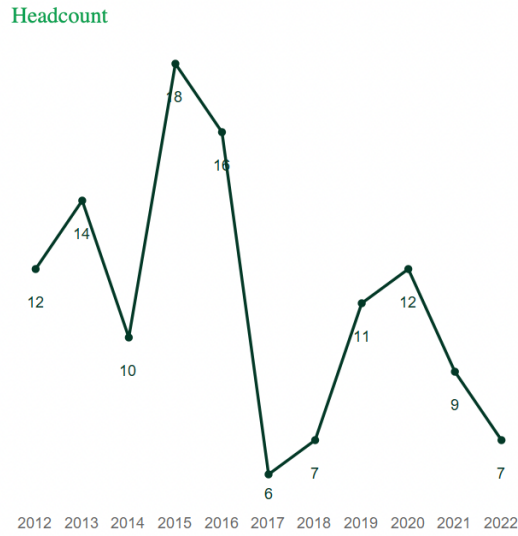
**Figure 5: CPE Graduate program student headcount: 2012 - 2022**

Likewise, the 10 –year average term GPA is shown below in Figure 6. Student performance, as measured by overall GPA, has kept well above 3.0. This trend shows that most students maintained "In Good Standing" status throughout their academic tenure in the graduate program.
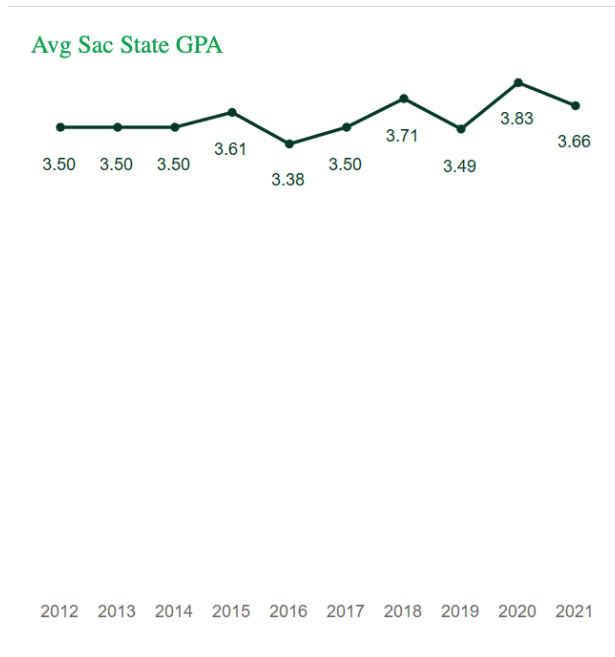


**Figure 6: CPE Graduate program average student GPA: 2012 – 2022**

## C. Graduation data disaggregated by gender and ethnicity

The table below shows the 4-year and 6-year graduation data disaggregated by gender and ethnicity for each degree.

**Table 11: Graduation data – 2016-2021**

| Year | 2016-2017 | 2017-2018 | 2018-2019 | 2019-2020 | 2020-2021 |
|---|---|---|---|---|---|
| Students graduated | 15 | 1 | 4 | 7 | 7 |

- A typical view of ethnicity and gender distribution is shown below for 2016-2021 CPE M.S. program graduates:

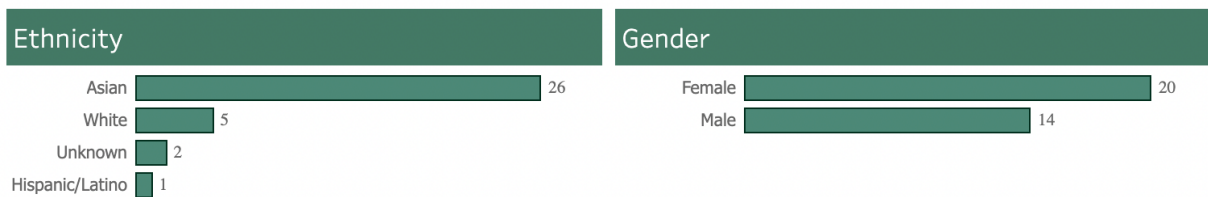  https://www.csus.edu/president/institutional-research-effectiveness-planning/dashboards/degrees-awarded.html



| Ethnicity | | Gender | |
|---|---|---|---|
| Asian | 26 | Female | 20 |
| White | 5 | Male | 14 |
| Unknown | 2 | | |
| Hispanic/Latino | 1 | | |

**Figure 7: Ethnicity and gender distribution of CPE MS program graduates– 2016-2021**

## D. Analysis on admission, retention, and graduation data

Below is the analysis on admission, retention, and graduation data, including how to maintain success and improve time to degree.

As seen from Figure 5, application, and admission numbers to the CPE Graduate Program have declined steadily during the 2019-2021 period, with significantly reduced international student admissions, primarily due to closure of U.S. consular visa offices around the world during the pandemic. The CPE program hopes to see admission being picked after the pandemic.

The following are the improvement tasks that we plan to implement over the next five years to improve the effectiveness of the program and increase both the overall number of majors and the diversity of the body of majors.

- Redefine our program PLOs to closely align with the institution-level PLOs.
- Refining the admission criteria.   We will continue our effort in refining the admission ranking criteria to further improve the diversity and inclusion of our admission for matriculating more minority students.

## E. Impaction plan

If the program is impacted, summarize data and future impaction plan.

The CPE Graduate program is not impacted.

## F. Current partnerships in success efforts

Summarize current partnerships in success efforts (Advising, Writing Center, Library Student Success Center, internship sites, etc.) and consider ways to better work together to maintain success and improve time to degree.

We have been collaborating with the ECS college advising center, the university writing center, the library student success center, and a number of internship sites and employers.

## Element Four: Developing Resources to Ensure Sustainability
### A. Key strategic initiatives

List key strategic initiatives for the academic unit, and append any strategic plan. These can be structural, such as new or discontinuations of degrees, concentrations, minors; tied to university strategic initiatives, such as Anchor University; or operational, such as ways to be more inclusive in the academic unit's planning.

The CPE program is involved in several efforts that would benefit people in Sacramento and surrounding regions. Some examples are given below.

- The CPE program has participated in the EEE department's multi-dimensional proposal with SMUD to renew power engineering laboratory to create a modern space including newer technology and state of the art implementation such as cyber security that does not exist in legacy devices.
- The CPE faculty has established the Educational Partnership Agreement (EPA) with the Defense Microelectronics Activity (DMEA) at McClellan Park in Sacramento. This close relationship has also greatly benefitted both the EEE and CPE students. For example, DMEA has donated a substantial amount of equipment to EEE over the years, which directly benefited the students who took the related EEE/CPE courses using the equipment.
- The CPE faculty are also involved in multiple NSF and NSA funded projects that train K-12 teachers to teach cybersecurity in their classes. For example, The National Cybersecurity Teaching Academy (NCTA) is a 12-credit hour graduate certificate for high school teachers (https://teachcyber.org/ncta-information/). It includes coursework on teaching cybersecurity, foundations of cybersecurity, network security, and advanced topics. Funded by the National Centers of Academic Excellence in Cybersecurity (located within the National Security Agency), and in partnership with the NCTA coalition, California State University, Sacramento (Sacramento State) is the fourth site to train high school teachers and grant graduate-level certificates to them for teaching cybersecurity.

The CPE program plans to improve the effectiveness of the program and increase both the overall number of majors and the diversity of the body of majors through the following strategies:

- Continue current efforts associated with the university strategic initiatives.
- Redefine our program PLOs to closely align with the institution-level PLOs.
- Refining the admission criteria.   We will continue our effort in refining the admission ranking criteria to further improve the diversity and inclusion of our admission for matriculating more local and minority students.

## B. Hiring needs

Summarize hiring needs for the academic unit, and append the multi-year faculty and staff hiring plan.

CPE program does not hire faculty independently. Rather, faculty hiring is conducted respectively in EEE and CSC departments. The CPE program recruits faculty from both EEE and CSC departments. Currently the CPE program is in shortage of faculty, mainly due to the faculty shortage in both EEE and CSC department. CPE program is usually composed of 5 faculty members from EEE department, and 5 faculty members from CSC department. However, currently we have 5 EEE faculty (4 tenure track, and 1 full-time lecturer) with 1 in FERP (Faculty Early Retirement Program), and 3 CSC faculty with 1 in FERP. Only 6 faculty members can serve on the CPE program committee in the Spring 2023 semester. With the ongoing hiring efforts and continuing hiring plan in both EEE and CSC department, we hope the faculty shortage issue can be addressed.

In addition, CPE program does not have independent supporting staff (ASC or ASA), and currently gets staff support from EEE department. The College of ECS has agreed to provide a student assistant to help support the program starting from Spring 2023.

## C. Budget concerns

Summarize other major budget concerns (facilities, equipment, student assistants, etc.).

The CPE program does not maintain budget independently.

## D. Revenue opportunities

Summarize revenue opportunities (grants, gifts, partnerships, etc.).

The CPE program does not maintain budget independently. All potential revenue (e.g. grants secured by CPE program committee members) goes to corresponding home departments (EEE or CSC).

## Element Five: Planning to Maintain Success and Engage in Continuous Improvement
### A. Summary of Areas of Concern and Means of Improving

The following are the main concerns and the improvement tasks that we plan to implement over the next five years:

- Redefine the CPE MS program PLOs. The current CPE MS program PLOs are aligned with the institution-level PLOs, but not on a one-on-one correspondence. This causes unnecessary inconvenience to the assessment process because: 1) CPE MS program relies on the data collected from EEE and CSC departments for assessments; 2) both EEE and CSC MS PLOs are aligned with the institution-level PLOs on a one-on-one correspondence; 3) extra mapping is needed to map the EEE and CSC PLOs to CPE PLOs. To address this issue, the CPE program committee will redefine our MS program PLOs to closely align with the institution-level PLOs. New PLOs will need to be discussed, reviewed, and approved by the CPE program committee.
- Refine the admission criteria. We will continue our effort in refining the admission ranking criteria to further improve the diversity and inclusion of our admission for matriculating more local and minority students.
- Get more faculty to serve on CPE committee. The CPE program is currently in shortage of faculty. We will continue working with EEE and CSC department to get more faculty serving on the committee.
- Review the prerequisites of graduate-level courses that CPE MS students take. Currently some graduate level EEE/CSC courses have pre-requisites that the graduate students may have taken in their undergraduate studies, but under a different course numbers/names, especially considering that most of our MS students are international students. Due to this, the graduate student cannot register the courses on their own. This is not only adding unnecessary extra workload to the CPE supporting staff, but also causes delay for students in getting into classes (some courses fill up very quickly). This can potentially delay students' graduation if students cannot get into the courses they need. Therefore, the CPE program committee will work closely with the EEE and CSC curriculum committee and review the graduate course prerequisites, to give graduate students ability to register courses on their own if they have already taken the required courses in their undergraduate studies.

# Appendix B. External Review Report Sample Template

**Academic Unit Name: Computer Engineering**

**Degrees: Masters**

**Site Visit Dates: March 6, 2023**

| STAGE | DESCRIPTION |
|---|---|
| **Initial** | The program is at a preliminary stage in this practice. The program shows the need for additional policies, resources, or practices in order for it to provide the education program to which it is committed or aspires. Insufficient data is available to make determinations. |
| **Emerging** | The program partially satisfies the criterion. Some data is available documenting this dimension. The program has many, but not all, of the policies, practices, and resources it needs to provide the educational program to which it is committed or aspires. |
| **Developed** | The program satisfies this criterion, with developed policies and practices. The program has the availability of sufficient resources to accomplish its program goals on this dimension. Data demonstrates accomplishment of this criterion. |
| **Highly Developed** | The program fully satisfies this criterion. The program may serve as a model and reference for others on campus. The program's practices, policies, and/or its resources contribute to program excellence on this dimension. |

| ELEMENT ONE: ACADEMIC UNIT'S MISSION AND INSTITUTIONAL CONTEXT | |
|---|---|
| **INQUIRY** | **STAGE** |
| Does the academic unit have a mission statement or statement of program goals that is appropriate? | D |
| Are the academic unit's mission and its programs aligned with CSUS and college missions and strategic priorities? | D |
| Is the academic unit supportive of the CSUS general education program and/or general graduate learning outcomes? | D |
| Does the academic unit engage key constituencies and campus partners in academic and strategic planning, including faculty, professional colleagues, current and prospective students, and the community? | E |
| Does the program have policies and procedures that facilitate articulation with community colleges and/or other external educational partners? | NA |
| Comments: See attached | |
| Recommendations: See attached | |

## ELEMENT TWO: LEARNING OUTCOMES AND ASSESSMENT TO MAINTAIN SUCCESS AND ENGAGE IN CONTINUOUS IMPROVEMENT

| INQUIRY | STAGE |
|---|---|
| Does each degree program have appropriate and measurable learning outcomes that reflect current standards in the discipline? | E |
| Does each course have appropriate and measurable learning outcomes that allow students to achieve program learning outcomes? | D |
| Are the curriculum and graduation requirements for each degree reflective of current standards in the discipline? | D |
| Are each degree's curriculum and graduation requirements appropriate for the degree level and do they reflect high expectations of students? | D |
| Is the assessment loop regularly being closed for each of the degree's program learning outcomes? | E |
| Is the learning assessment data being used to, per the Element Two heading, maintain success and engage in continuous improvement? | E |
| Do students feel connected to academic support services (writing, math, tutoring, library, etc.)? | NA |
| Comments: See attached | |
| Recommendations: See attached | |

## ELEMENT THREE: STUDENT SUCCESS AND ASSESSMENT TO MAINTAIN SUCCESS AND ENGAGE IN CONTINUOUS IMPROVEMENT

| INQUIRY | STAGE |
|---|---|
| Does each degree program use aggregated and disaggregated data to understand admission trends and to manage enrollment with an eye to diversity and impaction, or to address program-specific concerns? | E |
| Does each degree program use aggregated and disaggregated data to consider ways to improve retention? | E |
| Does each degree program use aggregated and disaggregated data to consider ways to improve time to degree or to close graduation gaps? | E |
| Does the program provide appropriate opportunities for students to participate in curricular-related activities, such as research and creative opportunities, service learning experiences, performances, and internships? | E |
| Does the program provide or partner with other entities to provide appropriate co-curricular activities for its students, such as clubs, field trips, lectures, and professional experiences? | E |
| Does the program provide adequate student advising? | E |
| Do students feel connected to student success support services? | NA |
| Comments: See attached | |
| Recommendations: See attached | |

## ELEMENT FOUR: DEVELOPING RESOURCES TO ENSURE SUSTAINABILITY

| INQUIRY | STAGE |
|---|---|
| Does the program have faculty in sufficient numbers and with appropriate rank, qualification, and diversity to allow students to meet the program learning outcomes and deliver the curriculum for each degree program? | E |
| Does the program employ professional staff and/or appropriately partner with campus partners (e.g., graduate studies or College of Continuing Education) to support each degree program? | E |
| Are the program's facilities, including offices, labs, and practice and performance spaces, adequate to support the program? | D |
| Does the program have access to information resources, technology, and expertise sufficient to deliver its academic offerings and advance the scholarship of its faculty? | D |
| Does the program seek and receive extramural support at the appropriate level, including grants, gifts, contracts, and alumni funding? | E |
| Has the program identified other concerns that impact budget and resource planning? | D |
| Comments: See attached | |
| Recommendations: See attached | |

## ELEMENT FIVE: PLANNING TO MAINTAIN SUCCESS AND ENGAGE IN CONTINUOUS IMPROVEMENT

| INQUIRY | STAGE |
|---|---|
| Does the academic unit engage in planning activities which identify its academic priorities and their alignment with those of the college and the university? | E |
| If appropriate, does the program have an advisory board or other links to community members and professionals? Does the program use community professional input for program improvement? Does the program maintain a relationship with its alumni? | E |
| Does the academic unit have a strategic plan, and other long term plans (5-year hiring, facilities, etc.)? | E |
| Does the academic unit have regular processes to revise plans and timelines? | E |
| Do plans include engagement with needed campus partnership and external entities to accomplish goals? | E |
| Comments: See attached | |
| Recommendations: | |

Commendations: See attached

Recommendations and Specific Considerations to Improve Learning and Student Success For Each Degree:

Recommendations and Specific Considerations to Develop Resources to Ensure Sustainability:

Recommendations and Specific Considerations to Improve Academic Unit Planning:

External Reviewer One Name: S. K. Ramesh Affiliation: California State University, Northridge

Signature: _____

External Reviewer Two Name: Kathleen Meehan Affiliation: California State University, Chico

Signature: _____

Comments, Commendations and Recommendations for the Masters degree program in Computer Engineering

The MS degree program in Computer Engineering lists faculty from the two supporting departments (Computer Science & Electrical and Electronics Engineering) who support the areas of specialization including Embedded Systems, Networking, Security, System Design, and Data Science. All students in the Master's degree program in Computer Engineering are required to complete a set of breadth courses covering Algorithms and Applications, Microelectronic design, Computer Architecture and Digital Design, Systems Software, in addition to a project or thesis. Based on the data from the self-study report it appears that students predominantly choose to complete the project option.

The program has proposed an assessment plan that maps Program Learning Outcomes with University Level Goals. With careful planning and regular assessment of PLO's in the core courses comprising the five areas, the program should have the information to make changes and close the loop for program improvement. The department offers industry relevant curricula in these areas, preparing graduates from the program for positions in digital and computer hardware, design and verification, system-level software development, prototyping and testing.

Faculty Hiring: Per the self-study report, there are currently 10-tenured/tenure-track track faculty in CPE but effectively 6 faculty who support the program. We learned during our virtual site visit that the college is presently recruiting for 10 tenure-track faculty with 50 % of the positions dedicated to the departments of Computer Science (3 positions) and Electrical & Electronic Engineering (2 positions).

Faculty Research: The CSC and E&EE departments have hired several new tenure-track faculty in the last 3 years and working hard to enable their success in the classroom and with their research. Support in the form of release time (6 units/year) for two years is common for all new faculty. Additionally the college and the university have several mechanisms in place to provide release time to support faculty research. Also there is the potential to connect graduate students interested in pursuing the PhD with suitable doctoral programs in the region.

Recommendations:

**1. Develop a plan to diversify the student body with strategies to incentivize and recruit resident students including graduates from the BS degree programs in Computer Engineering, Computer Science and EEE.**

*Student enrollment in the program is surprisingly low (in single digits) for an area that is in great demand in industry and is expected to grow significantly in the near term. A coordinated recruitment effort is required to attract students and strengthen enrollment.*

**2. Carefully assess and coordinate proposed PLO's to ensure consistency across required core courses for the MS in Computer Engineering program.**

*The program is jointly supported by faculty members who are from the departments of Computer Science and Electrical & Electronic Engineering. Courses in the program are either from CSC or EEE and follow the assessment protocols of the respective departments. Faculty teaching in the program will need to work in close coordination with the Computer Engineering program coordinator to ensure consistency across required core courses.*

**3. A 3-5 year hiring plan to recruit new tenure track faculty and replace retiring faculty.**

*The two departments supporting the program expect to hire a total of 5 tenure-track faculty during the hiring cycle this year. Some of these faculty may be from areas that are aligned with the core areas of the Computer Engineering program. The two supporting departments need to work in close coordination and intentionally focus on hiring faculty who will support the Computer Engineering program considering the opportunities and potential for future growth and development.*

**4. Curriculum Development**

*The core components of the program such as Security, Embedded Systems, and Data Science have tremendous potential for growth given the increasing interest in areas such as Cybersecurity. This is an opportunity to attract students to the program and strengthen enrollment.*

# Internal Review Report

| | |
|---|---|
| Internal Review Report: | Computer Engineering |
| College: | College of Engineering & Computer Science |
| Degree Programs: | **MS in Computer Engineering** |
| | |
| Internal Reviewers: | Ben Amata, Library |
| | Pooria Assadi, College of Business |
| | |
| Date Submitted: | June 13, 2023 |

## I.  Context:

The Department Computer Engineering submitted a 20-page Self-Study in Fall, 2022 that conformed structurally to the Self-Study requirements in the *Academic Program Review Guide* (referred to as the *Guide*). It was timely and complete, and comprehensive in that it addressed all the elements but lacked sufficient self-reflection. ***The IRs overall recommendation is that all of the Department's faculty read the Civil Engineering Department's Self-Study for an example of an exceptionally well-done Self-Study with excellent self-reflection.***

External Reviewers provided 4 commendations. 1. Develop a plan to diversify the student body with strategies to incentivize and recruit resident students including graduates from the BS degree programs in Computer Engineering, Computer Science and EEE. 2. Carefully assess and coordinate proposed PLO's to ensure consistency across required core courses for the MS in Computer Engineering program. 3. A 3-5 year hiring plan to recruit new tenure track faculty and replace retiring faculty. 4. Curriculum Development. The IRs will respond to the 4 recommendations when appropriate in their report.

The External Reviewers (ERs) were Dr. S.K. Ramesh, Director of the AIMS program, College of Engineering and Computer Science, California State University Northridge and Dr. Kathleen Meehan, Chair, Department of Electrical Engineering, California State University, Chico.

According to the ER's schedule the March 6, 2023 via Zoom conformed to the *Guide's* requirements.

## II. Recommendations:

**Element 1. To Maintain Success**

In their Self-Study, the Department highlights that they "partner up with local community colleges to transfer students to the program; reach out to local high schools for attracting high school students; team with San Francisco State, San Jose State, and Sonoma State for the "CSForAll" initiative." The IRs recommend that the Department takes advantage of these and other similar outreach efforts in the region as they relate to the overall success of the Department's mission in general and its recruitment efforts in particular. Even as the Department offers the "10-year history of student headcount in the CPE graduate program" in Figure 5 and offers some admission and retention data, it does not offer much reflective analysis to interpret them.

In addition, the Department offers very basic descriptive data on application, admission, and retention dimensions across race and ethnicity. While the IRs appreciate this effort, they strongly encourage to offer more analysis and discuss their plans to improve diversity in their recruitment efforts (i.e., expand Self-Study, Student Success" p 13-16).

These would be in keeping with one of ERs' recommendation (Comments, Commendations and Recommendations p 1) that the Department should "develop a plan to diversify the student body with strategies to incentivize and recruit resident students including graduates from the BS degree programs in Computer Engineering, Computer Science and EEE." This recommendation was based on their observation that "student enrollment in the program is surprisingly low (in single digits) for an area that is in great demand in industry and is expected to grow significantly in the near term. A coordinated recruitment effort is required to attract students and strengthen enrollment."

*Recommendation R.1.1: The IRs recommend that the Department analyze and take advantage of potential student recruitment opportunities in their outreach efforts in the region.*

*Recommendation R.1.2: The IRs recommend that the Department include in its Self-Study a data-driven plan for student diversity.*

## Element 2. To Improve Student Learning (consider university/college goals on learning, research/scholarship, diversity)

Faculty from the CSc and EEE departments teach the CpE, CSc, and EEE courses that constitute the CpE master's degree, and the program's assessment relies on data that the two departments provided where each uses its own PLOs. The programs goals are congruent with the University's graduate PLOs. The Self-Study furnished 2 years of data (2020/2021 and 2021/22). Student achievement has increased, stayed level, or improved depending on the goal (see figure 1). For PLO 1 (disciplinary knowledge), 100% of students achieved it since 2016.

| PLO# & goal | 2020/21 | 2021/22 |
|---|---|---|
| 2 (communication) | 100% | 60% |
| 3, 4 (critical thinking, information literacy) | 100% | 80% |
| 5 (professionalism) | 50% | 60% |
| 6 (Intercultural/Global Perspectives) | 50% | 50% |

**Figure 1**

For section C, Analysis, the faculty didn't provide any or minimal reflection. Why have they seen such strong performance for PLO1 (100% for the last 5 years)? Is it maturation? Have they analyzed assignments in their courses? Since they conduct assessment from 3 sets of courses (CpE, CSc, and EEE) is there any coordinated examination or just adding different course assessments together? They did not mention whether or not they used rubrics, or if there was a committee or a team that evaluated meeting their goals. Programmatic assessment isn't individual faculty evaluating individual direct measures (student work) for just their courses; it is sampling of student work evaluated using rubrics to standardize the assessment. For small programs, faculty can review all student's work if they think worthwhile. This is particularly a challenge with blended programs where a department isn't responsible

but instead faculty from different departments teach individual courses and no faculty or team is analyzing programmatically. A team or assessment group can make sure there is consistency and cohesion in assessing the PLOs. The ERs second recommendation Comments (Comments, Commendations and Recommendations p 1) was similar: "Carefully assess and coordinate proposed PLO's to ensure consistency across required core courses for the MS in Computer Engineering program. The program is jointly supported by faculty members who are from the departments of Computer Science and Electrical & Electronic Engineering. Courses in the program are either from CSC or EEE and follow the assessment protocols of the respective departments. Faculty teaching in the program will need to work in close coordination with the Computer Engineering program coordinator to ensure consistency across required core courses."

For PLO 2 (communication) student performance declined. The faculty reiterated their summary of results (Self-Study p 8): "Research Methodology course is mandatory for all beginning first-semester CPE graduate students. The satisfactory percentage for the 2020/2021 year is 100%, while for the 2021/2022 year is 60%." Why the decline? Was this a statistical anomaly? How can they analyze their evidence to determine what improvements to try?

For PLOs 3 (critical thinking) students achieve 100% of the goal since 2016 and therefore the faculty could have stated they cannot improve performance, if they indeed have concluded their assignments adequately provide evidence that they meet the goal.

For PLO 4 (information literacy, Self-Study p 8) performance decreased from 100% to 80%. Yet they described it tentatively: "Generally, the performance of students *seems to be excellent* [IRs bold font and italics], and students are able to access and list relevant reference sources satisfactorily." Was the decline a statistical anomaly of a small numbers or are they not confident in their evidence?

For PLO 5 (professionalism), they indicated initially there was only a 50% satisfactory performance for 2020/21 and 60% for 2021/22 (Self-Study p 8). "It is of concern that 50 % or higher number of student reports are not reaching satisfactory levels of original content in writing. It is acceptable for students to access material for their reports from external sources, including the internet; however, further training is required to improve students' ability to appropriately reference and present material in their own words." The faculty identified that the students need more training which may well be the problem; this goal is where surveying the students (an indirect measure) may prove fruitful and provide direction for the type of assignments faculty need to create to improve performance.

For PLO 6, (Intercultural/Global Perspectives, Self-Study p 8), they concluded: "The percentages shown reflect the number of thesis/project topics that are directly relevant to global issues. While all graduate projects have some useful applications, examples of CPE project topics that have components of global relevance are research in image classification, security analysis of computer systems etc." The achievement level is only 50% for both years. That faculty utilizing assignments for more than one assessment goal is an efficient and effective practice. Perhaps students could demonstrate greater achievement through a set of better tailored assignments in a course or courses rather than the thesis/project?

Section D requests other relevant data. The supplied the questions from the Alumni Survey but not the results. This represented another lost opportunity for reflection. Combining indirect measures of student's perceptions of their skills and abilities when compared with direct measures provides a robust assessment program besides furnishing insights about student learning and achieving goals.

The IRs commend the program for including their assessment plan in their Self-Study. While the University doesn't require that programs use their assessment plan for tracking successes and areas for improvement, the faculty may want to do it as a way to remain aware of the iterative assessment process, which will aid them in producing future work and self-studies.

*Commendation: 2.C.1: IRs commend the Department for mapping program goals to the University PLOs.*

*Recommendation: 2.R.1: IRs recommend that an assessment committee or team conduct assessment and report back to all faculty teaching in the program assessment results. Periodic meetings to discuss programmatic assessment would be useful for participating faculty. If they are already doing this then the self-study should note this.*

*Recommendation: 2.R.2: IRs recommend that faculty use rubrics for assessing PLOs. If they are already doing this then the self-study should note this.*

*Recommendation: 2.R.3: IRs recommend that the faculty consider developing assignments for achieving PLO 6 (Intercultural/Global Perspectives) in a course or courses rather than relying on the thesis/project.*

*Recommendation: 2.R.4: IRs recommend that the faculty discuss the findings of indirect measures in future self-studies and combine them with direct measures to develop a more robust assessment program.*

*Recommendation: 2.R.5: IRs recommend that the faculty consult with an Office of Academic Program Assessment representative to discuss their assessment practices for possible improvements.*

*Recommendation: 2.R.6: IRs recommend that the faculty consider including in their assessment plan tracking successes and areas needed for improvement as a way to remain aware of the iterative assessment process.*

### Element 3. To Improve Student Success (consider university/college goals on recruitment, retention, graduation, diversity, engagement)

The BLS's *Occupational Outlook Handbook* categorizes individuals in the field as computer hardware engineers, who research, design, develop, and test computer systems and components. BLS projects employment to grow 5 percent from 2021 to 2031, about as fast as the average for all occupations. There are approximately 5,300 openings for computer hardware engineers projected on average each year over the decade. Many of those openings will result from the need to replace workers who transfer to different occupations or exit the labor force (e.g. retirement).
[Computer Hardware Engineers : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)](bls.gov)

Unfortunately, BLS does not count computer hardware engineers locally in its *Metropolitan and Nonmetropolitan Area Occupational Employment and Wage* Estimates *Sacramento--Roseville--Arden-Arcade, CA,* as it does for other engineering careers. Sacramento--Roseville--Arden-Arcade, CA - May

[2022 OEWS Metropolitan and Nonmetropolitan Area Occupational Employment and Wage Estimates (bls.gov)](#) It does count the number for the state, 26,270, as of May 2022.

The National Science Foundation doesn't enumerate master's degrees (including ethnic/racial and gender diversity) awarded as it does for other engineering degrees.

The faculty reported that their program is small and enrollment is declining (16 students in fall 2016 and 7 in 2022) which they attributed to "significantly reduced international student admissions, primarily due to closure of U.S. consular visa offices around the world during the pandemic. It hopes that admissions will increase after the pandemic. If it doesn't, the 2 departments will have to address the viability of offering the program.

The ERs recommended (Comments, Commendations and Recommendations p 1) that the program racially/ethnically and gender diversify. "1. Develop a plan to diversify the student body with strategies to incentivize and recruit resident students including graduates from the BS degree programs in Computer Engineering, Computer Science and EEE. Student enrollment in the program is surprisingly low (in single digits) for an area that is in great demand in industry and is expected to grow significantly in the near term. A coordinated recruitment effort is required to attract students and strengthen enrollment." Self-Study (p 15 & 17) demonstrated that females make up a valuable and significant enrollment in the program. Racially/ethnically diversity is an area for possible increases. The IRs recommend that the faculty survey other departments and review the literature for strategies (see appendix) and techniques for increasing diversity (see appendix). There may not be articles for the specific field, but ideas from other similar fields, e.g. computer science and EEE, may be helpful.

The ERs statement that there is great demand doesn't comport with the BLS's estimates which would be more thorough and accurate.

Besides the ERs recommendation for advertising to undergraduate students in engineering programs, the Department should consider an open house (in-person and/or virtual). Arizona State University created a checklist for successful graduate student enrollment that the faculty can experiment with. (https://graduate.asu.edu/sites/default/files/gradrecruitmentbestpractices-feb2017.pdfhttps://graduate.asu.edu/sites/default/files/gradrecruitmentbestpractices-feb2017.pdf

***Commendation: 3.C.1: IRs commend the faculty on successfully enrolling female students.***

***Recommendation: 3.R.1: IRs recommend reviewing the literature and surveying similar programs/colleagues for ideas.***

***Recommendation: 3.R.2: IRs recommend experimenting with open houses as a possible recruitment technique.***


## Element 4. 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 has an opportunity to use more partnerships in their program development to enhance student experience. In their Self-Study, in a section entitled "Current partnerships in success efforts,"

the Department noted (Self-Study p 18) that "we have been collaborating with the ECS college advising center, the university writing center, the library student success center, and a number of internship sites and employers." However, much reflection is absent to elaborate on these opportunities and how they might improve student success.

In addition, in their Self-Study, in a section entitled "Key strategic initiatives," the Department indicated Self-Study p 18) that "the CPE faculty are also involved in multiple NSF and NSA funded projects that train K-12 teachers to teach cybersecurity in their classes." At the same time, the Department does not seem to be currently reflecting on using this competitive advantage in attracting more students and enhancing their experience "as a certificate granting institution within the National Cybersecurity Teaching Academy (NCTA)."

Such reflections can potentially address an ER's observation (Comments, Commendations and Recommendations p2) regarding "Curriculum Development" noting that "the core components of the program such as Security, Embedded Systems, and Data Science have tremendous potential for growth given the increasing interest in areas such as Cybersecurity. This is an opportunity to attract students to the program and strengthen enrollment."

***Recommendation 4. D.1: The IRs recommend that the Department consider and assess using their outreach efforts to enhance student enrollment and experience.***

***Recommendation 4. D.2: The IRs recommend that the Department build on their competitive advantage (e.g., Cybersecurity) to enhance student enrollment and experience.***

## Element 5. 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)

The Self-Study offered some strategies for maintaining and enhancing the program quality and sustainability including structural changes and enhancement to the program since last review, including participating in renewing power engineering laboratory, establishing the Educational Partnership Agreement (EPA) with the Defense Microelectronics Activity (DMEA) at McClellan Park in Sacramento, and training K-12 teachers to teach cybersecurity in their classes, among others.

The Self-Study (p 19) also noted that "currently the CPE program is in shortage of faculty, mainly due to the faculty shortage in both EEE and CSC department" and that the "CPE program does not have independent supporting staff (ASC or ASA), and currently gets staff support from EEE department." While the Department mentioned that "the College of ECS has agreed to provide a student assistant to help support the program starting from Spring 2023," its shortage of faculty and support staff remain a challenge. Even as the "CPE program does not hire faculty independently," they could reflect more on how they might engage with the EEE and CSC departments for faculty recruitment, including their plans for part-time faculty hiring.

This would be consistent with ER's recommendation (Comments, Commendations and Recommendations p 1) to the Department to develop a "3-5 year hiring plan to recruit new tenure track faculty and replace retiring faculty" and work with EEE and CSC departments to benefit from faculty

hires who may work in "areas that are aligned with the core areas of the Computer Engineering program."

***Recommendation 5.R.1: The IRs recommend that Department develop a plan that includes engagement with the EEE and CSC departments for their academic personnel hiring needs that incorporates full-time and part-time faculty as well as any student assistants.***

## III. Appendix:

Kuleshov, Y. A., Rada, M. E., & Lucietto, A. M. (2021). Minority Graduates in Engineering Technology: Trends in Choice of Major. ASEE Annual Conference and Exposition, Conference Proceedings.

Lucietto, A. M., & McNally, H. A. (2017). Encouraging the diversity of graduate students in technology. Proceedings - Frontiers in Education Conference, FIE, 2017-October, 1–5. https://doi.org/10.1109/FIE.2017.8190483

Manoharan, S., Choudhuri, S., Krug, B., & Plotkowski, P. D. (2022). Developing a Strategy to Include Financially Disadvantaged Undergraduate Students into Graduate Engineering Programs. 2022 CoNECD - Collaborative Network for Engineering and Computing Diversity.

# MOU/Action Plan

**Program: Computer Engineering (CpE) Master of Science**
A jointly supported program with EEE and CSC departments

College: ECS

Date:9/19/2023

| Program Review Finding | 2 YR | 4 YR | 6 YR |
|---|---|---|---|
| Cite self-study, external review, internal review, and/or accreditation documentation | List goal, success indicator, responsible parties, and resource implications. | List goal, success indicator, responsible parties, and resource implications. | List goal, success indicator, responsible parties, and resource implications. |
| **To Maintain Success** | | | |
| Develop graduate pathways that engage students and local industries.<br><br>Maintain faculty consistency teaching in the CpE program. | Review curriculum and evaluate the core and breadth subject requirements to better align with market trends in both hardware and software-related subject areas.<br><br>Consult with industry advisory council members, survey alumni, and evaluate the feasibility of creating CPE | Review enrollment trends and evaluate assessment results to ensure student and program success.<br><br>Communicate/consult with the respective EEE and CSC departments regarding faculty hiring needs for the CpE program. | Evaluate the growth trends in both EEE and CSC subject areas that impact CpE.<br><br>Review enrollment trends and evaluate assessment results to ensure student and program success. |

| | hardware-oriented and CPE software-oriented degree paths to better meet the applicants' educational backgrounds and interests and help increase diversity and enrollment in the program.

Examine the entrance and degree requirements for a 2-year graduation target and its feasibility. | | |
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| **To Improve Student Learning** (consider university/college goals on learning, research/scholarship, diversity) | | | |
| Assess and coordinate the updated PLOs to ensure consistency across required core courses.

Ensure the curriculum meets the program objectives. | Reevaluate the curriculum to better align with the updated PLOs. | Faculty to review and evaluate assessment results to ensure student learning in the program.

Analyze and discuss the assessment results of each PLO to ensure student learning. Reevaluate course(s), delivery, degree path, etc. if necessary. | Repeat the previous step to ensure student learning.

Analyze enrollment trends to assess student interests in the subject areas and evaluate the areas of most and least concentrations to ensure meeting the program objectives. |
| **To Improve Student Success** (consider university/college goals on recruitment, retention, graduation, diversity, engagement) | | | |

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| Improve enrolment trends to ensure program success. | Communicate with the undergraduate CpE Alumni to share information about the graduate program and seek inputs (via a survey). | Evaluate the information received from the undergraduate CpE Alumni survey to improve enrollment and diversity in the graduate program.<br><br>Evaluate the feasibility and effectiveness of developing a blended five-year bachelor's/master's pathways to increase diversity and enrolment into the program and better meet the needs of the industry. | Review and reevaluate the Student Success. |
| **To Build Partnerships and Resource Development to Enhance the Student Experience** (consider university/college goals on university as place, university experience, community engagement) | | | |
| Evaluate the feasibility of adding optional internship units into the degree program (e.g., CpE 295, Fieldwork). | Evaluate the program to incorporate optional 1, 2, or 3 units of internships with industry to enhance student engagement in the community. | Evaluate the supervisors' evaluations of the interns for the effectiveness of the program in relation to the objectives of the course, the program PLOs, and the degree. | Review the effectiveness of the internship program in meeting the goals of the program. |

| To Improve Strategic & Budget and Operational Effectiveness and to Ensure Sustainability (consider university/college goals on innovative teaching, scholarship, research, university as place, university experience) | | | |
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| Improve information sharing with the EEE and CSC departments that jointly support the CpE undergraduate and graduate programs. | Standardize communication protocols with EEE and CSC departments to enhance information sharing such as students' progress in the degree, a 2-year graduation target that may impact course offerings), industry relationships, etc. | Review the information sharing for its effectiveness with the EEE and CSC departments and update. | Review the information sharing for its effectiveness with the EEE and CSC departments and update. |

**CpE Program Coordinator Name/Signature**

Nikrouz Faroughi        *N. Faroughi*

**Department Chair Name/Signature**

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EEE:        *M. Zarghami*

*K. Shahrjadi*
**College Dean Name/Signature**

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