Learning Outcomes Data
for the
Senate Committee on
Instructional Program Priorities

Program: Electrical and Electronic Engineering (EEE)
Department: Electrical and Electronic Engineering
Number of students enrolled in the program in Fall 2011: 228
Faculty member completing template: Dr. Suresh Vadhva
Date: 1/3/2012
1. Please describe your program’s learning-outcomes trajectory since 2006-07: Has there been a transformation of organizational culture regarding the establishment of learning outcomes and the capacity to assess progress toward their achievement? If so, during which academic year would you say the transformation became noticeable? What lies ahead; what is the next likely step in developing a learning-outcomes organizational culture within the program?

The Accreditation Board for Engineering and Technology (ABET) is a nonprofit, non-governmental organization that accredits college and university programs in the disciplines of applied science, computing, engineering, and engineering technology. ABET provides specialized, programmatic accreditation that evaluates an individual program of study, rather than evaluating an institution as a whole. The Electrical and Electronic Engineering Undergraduate program has been ABET accredited for over 20 years and as part of that accreditation the assessment process has been embedded in our program. We will continue as required by ABET to incorporate assessments into our program and adhere to the assessment process. The complete self study document is available upon request.

2. Please list in prioritized order (or indicate no prioritization regarding) up to four desired learning outcomes (“takeaways” concerning such elements of curriculum as perspectives, specific content knowledge, skill sets, confidence levels) for students completing the program. For each stated outcome, please provide the reason that it was designated as desired by the faculty associated with the program. [Please limit your response per outcome to 300 words or less].

All the learning outcomes listed below are important and all are necessary to perform assessment of the EEE program:

a. an ability to apply knowledge of mathematics, science, and engineering or computing as appropriate to discipline
b. an ability to design and conduct experiments, as well as to analyze and interpret data, or an ability to analyze a problem and identify and define the computing requirements appropriate to solution
c. an ability to design a system, component, program or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
d. an ability to function on multidisciplinary teams
e. an ability to identify, formulate, and solve engineering problems
f. an understanding of professional and ethical responsibility
g. an ability to communicate effectively
h. an understanding of the impact of engineering or computing solutions in a global, economic, environmental, and societal context
i. a recognition of the need for, and an ability to engage in life-long learning and continuing professional development
j. a knowledge of contemporary issues
k. an ability to use the techniques, skills, and modern engineering and computing tools necessary for engineering or computing practice.

Specifically, the EEE faculty has adopted a set of 15 student learning outcomes which define what students are expected to know and be able to do by the time they graduate. These parallel to the requirements of ABET Engineering Criterion 3 items (a) through (k) and applicable Program Criteria. This relationship is detailed parenthetically below.

1. A knowledge of mathematics through differential and integral calculus, differential equations, physics and chemistry (Program Criteria)
2. A knowledge of basic engineering sciences including statics and dynamics (Program Criteria)
3. The ability to apply knowledge of mathematics, science and engineering to solve problems in E&EE (Engineering Criterion 3(a))
4. A knowledge of core E&EE topics in circuits, electronics, communications, control systems, microprocessors, electromagnetics, and electric machines (Program Criteria)
5. Depth in at least one area of E&EE out of Analog/Digital Electronics, Control Systems, Communications and Power. (Engineering Criterion 3(j), Program Criteria)
6. Knowledge of probability, statistics and applications to E&EE. (Program Criteria)
7. The ability to use contemporary engineering techniques and tools for analysis and design. (Engineering Criterion 3(k))
8. The ability to work with modern instrumentation, software and hardware, design and perform experiments, and analyze and interpret the results. (Engineering Criterion 3(b), Program Criteria)
9. The ability to integrate knowledge gained from the core curriculum to solve a complex design problem. This includes the identification, specification, design and implementation of products/components and/or systems that meet desired safety, economic and performance criteria. (Engineering Criterion 3(c, e), Program Criteria)
10. The ability to function on multi-disciplinary teams and exercise leadership to accomplish project goals. (Engineering Criterion 3(d))
11. The ability to communicate effectively through written technical papers and/or project reports. (Engineering Criterion 3(g))
12. The ability to make effective oral presentations and convey technical material to an audience. (Engineering Criterion 3(g)).
13. An understanding of professional and ethical responsibility and a broad education to appreciate the impact of engineering solutions in the societal context. (Engineering Criterion 3(f, h))
14. Recognition of the need for and an ability to engage in “life-long” learning. (Engineering Criterion 3(i))
15. An appreciation for and knowledge of diverse cultures and demonstrated proficiency in a foreign language.
3. *For undergraduate programs only*, in what ways are the set of desired learning outcomes described above aligned with the University’s Baccalaureate Learning Goals? Please be as specific as possible. [Please limit your response per outcome to 300 words or less]

Electrical and Electronic Engineering Educational objectives are consistent with Baccalaureate Learning Goals. The matrix below is developed to relate the two.

**EEE Program Outcomes as Related to California State University, Sacramento’s Baccalaureate Learning Goals**

<table>
<thead>
<tr>
<th>ECS Matrix</th>
<th>BACCALAUREATE LEARNING GOALS</th>
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<tbody>
<tr>
<td></td>
<td>Competencies in the Disciplines</td>
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<tr>
<td>Learning Outcomes</td>
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<td>(a)</td>
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4. For each desired outcome indicated in item 2 above, please:
   a) Describe the method(s) by which its ongoing pursuit is monitored and measured.
   b) Include a description of the sample of students (e.g., random sample of transfer students declaring the major; graduating seniors) from whom data were/will be collected and the frequency and schedule with which the data in question were/will be collected.
   c) Describe and append a sample (or samples) of the “instrument” (e.g., survey or test), “artifact” (e.g., writing sample and evaluative protocol, performance review sheet), or other device used to assess the status of the learning outcomes desired by the program.
   d) Explain how the program faculty analyzed and evaluated (will analyze and evaluate) the data to reach conclusions about each desired student learning outcome.
[Please limit your response to 200 words or less per learning outcome]

(If the requested data and/or analysis are not yet available for any of the learning outcomes, please explain why and describe the plan by which these will occur. Please limit your response to 500 words or less.)

The following assessment instruments are used in our program:

1. **Course Embedded Assessment:** Course Embedded Assessment represents the "bricks and mortar" of our assessment program. Our experience shows that assignments and exams in individual courses provide immediate and valuable feedback to both the student and the faculty. Assignments and examinations including mid-terms and final are required in all courses. In addition, projects, Computer Aided Design and term papers are required in several classes as appropriate. They allow the faculty to identify any potential problems in related courses, i.e. if the performance of several students in a given exam or assignment indicates that they do not understand a concept they should have acquired in a prerequisite course, that probably indicates a problem with the related course. We have established a Course Embedded Assessment (CEA) process that focuses on a set of core classes required of all students in our major. Each course has detailed objectives, specific course outcomes, and indicators that are monitored to ensure successful achievement of those outcomes. The Course Coordinators for courses covered by CEA present a report to the Department faculty reflecting on student achievement on the specific course outcomes and course topics, whether prerequisites are appropriate, student reaction to the course, and suggested changes if any.

2. **Surveys**
   a) **Graduating Seniors:** Graduating seniors are surveyed at the time of graduation for their perceptions about the program's educational objectives and student learning outcomes, our relative success in achieving those outcomes, and suggestions for improvement.
   b) **Alumni:** Alumni from our program are surveyed three years out to rank the importance of each of our Program Educational Objectives and Student Learning Outcomes in the context of their current professional position and their level of preparation with respect to that objective or outcome.
   c) **Employer:** The College’s Career and Placement Office periodically surveys employers and provides salary information and relevant information on upcoming trends and opportunities to the programs.

3. **Industry Focus Teams Visits:** Faculty teams visit a company or industry that employs several graduates from our program to meet with a group of our alumni. Typically the alumni include recent graduates (1-5 years out), as well as experienced engineers and managers (6-10 years out, 11 years and over). A set of open-ended questions is distributed to the site prior to the visit to provide a foundation for the participants. The reports are analyzed by the faculty and action items with appropriate timelines are developed for implementation.

4. **Industry Liaison Council (ILC):** The EEE program enjoys a relationship with engineers from industry representing all major areas of emphasis in the EEE program. The program meets with
industry representatives biannually and the industry representatives provide the program and the faculty with independent feedback on its efforts to achieve the Program Educational Objectives.

5. **Industry Advisory Board**: At the College level, the IAB receives reports from each program on a biannual basis and evaluates each program’s success in implementing the strategic plan of the college. The IAB meets in executive session following the presentations and reports back to the Program Coordinators, Department Chairs and Deans with specific recommendations for follow up and action.

<table>
<thead>
<tr>
<th>Constituency</th>
<th>Specific Group</th>
<th>Timelines</th>
<th>Type of Feedback</th>
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<tbody>
<tr>
<td>Students</td>
<td>All students</td>
<td>Every year</td>
<td>Student Survey</td>
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<td></td>
<td></td>
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<td>Course embedded assessment</td>
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<tr>
<td>Alumni</td>
<td>Graduating classes 5 years</td>
<td>Every 3 years</td>
<td>Alumni Survey</td>
</tr>
<tr>
<td>Faculty</td>
<td>Full time and part time</td>
<td>Every three years</td>
<td>Faculty Survey</td>
</tr>
<tr>
<td>Employers</td>
<td>Industry Liaison Council</td>
<td>Every semester</td>
<td>Biannual meeting discussions</td>
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<td>Annual report</td>
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<td></td>
<td>ECS College Industry Advisory Board</td>
<td>Every year</td>
<td>Biannual Report</td>
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<tr>
<td>Industry Focus Team Visits</td>
<td>Managers and Alumni</td>
<td>Every year</td>
<td>Report</td>
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5. Regarding each outcome and method discussed in items 2 and 4 above, please provide examples of how findings from the learning outcomes process have been utilized to address decisions to revise or maintain elements of the curriculum (including decisions to alter the program’s desired outcomes). If such decision-making has not yet occurred, please describe the plan by which it will occur.

**[Please limit your response to 200 words or less per item]**

*Example on how we improve our program from analysis of surveys:* The Educational Objectives dealing with the application of mathematics, science and engineering, problem solving, and teamwork were rated highly in the last two surveys conducted in 2003-2004 and 2007-2008. Of the Educational Objectives (Eos) rated lower in the surveys of 2003-2004, the faculty decided that we needed to focus on, dealing with the communication skills of our graduates amid the continuous improvement of the overall curriculum in terms of all outcomes. This is also consistent with the EEE ILC’s top recommendation for continuous improvement. In order to implement these recommendations, the faculty have introduced project reports and presentations in several courses in the curriculum. As examples, in EEE 161 Applied Electromagnetics a presentation of application of electromagnetics theory was introduced. In
ENGR 17 in quizzes and exams questions were asked that required a written paragraph for an answer. These were graded for content and writing.

Example on how we improve our Program from Industry Focus Team Visits and Industry Liaison Council: Data was collected from the visits on strengths and weaknesses of alumni, followed by an independent analysis by EEE ILC and department faculty. The following items were identified to be important for EEE program improvement.

- Lab courses and senior project considered most valuable experiences,
- Excellent engineering fundamentals education,
- Very good overall breadth of education,
- Need more project management, teamwork, people, and business skills,
- Need to teach more current engineering trends (high-speed transmission, power, analog/digital/VLSI design, applied statistics/statistical process control, printed circuit board design and manufacturing, semiconductor fabrication processing, wireless, optical, statics/dynamics, PC skills, and software applications/theory, and also include embedded systems applications),

We have introduced several new courses in the area of circuit design, electronics, semiconductor fabrication, VLSI developed rubrics and evaluated oral, written communications, teamwork, purchased a PC board milling machine, introduced semiconductor fabrication course for graduate students, and improved advising by creating an advising center located in EEE main office. To improve engineering fundamentals education, the EEE Department has assigned full-time faculty to teach core courses.

6. Has the program systematically sought data from alumni to measure the longer-term effects of accomplishment of the program’s learning outcomes? If so, please describe the approach to this information-gathering and the ways in which the information will be applied to the program’s curriculum. If such activity has not yet occurred, please describe the plan by which it will occur.

[Please limit your response to 300 words or less]

In particular, alumni of the program represent a much broader spectrum of individuals with a wide range of experience in their lives and careers. It is very important to include their feedback in evaluating the program’s success in meeting its desired Program Educational Objectives, and Alumni input is sought through standard surveys. Based on the information collected, EEE faculty members analyze and evaluate the information by comparing it to the specified learning outcomes. Then, changes are made to the objectives as needed.

7. Does the program pursue learning outcomes identified by an accrediting or other professional discipline-related organization as important? Does the set of outcomes pursued by your program exceed those identified as important by your accrediting or other professional discipline-related organization?

[Please limit your response to 300 words or less]
The EEE Department meets the criterion established by ABET Engineering Criterion 3, which states Engineering programs must demonstrate that their students attain the following outcomes:

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

The EEE faculty has adopted a set of 15 “Student Learning Outcomes” or SLOs, which define what students are expected to know and be able to do by the time they graduate. These SLOs coincide with the requirements of ABET Engineering Criterion 3, items (a) through (k) and applicable Program Criteria, and this relationship is detailed parenthetically below.

All students of the EEE program at CSUS are expected to have at the time of graduation:
1. A knowledge of mathematics through differential and integral calculus, differential equations, physics and chemistry
2. A knowledge of basic engineering sciences including statics and dynamics
3. The ability to apply knowledge of mathematics, science and engineering to solve problems in E&EE
4. A knowledge of core E&EE topics in circuits, electronics, communications, control systems, microprocessors, electromagnetics, and electric machines
5. Depth in at least one area of E&EE out of Analog/Digital Electronics, Control Systems, Communications and Power.
6. Knowledge of probability, statistics and applications to E&EE.
7. The ability to use contemporary engineering techniques and tools for analysis and design.
8. The ability to work with modern instrumentation, software and hardware, design and perform experiments, and analyze and interpret the results.
9. The ability to integrate knowledge gained from the core curriculum to solve a complex design problem. This includes the identification, specification, design and implementation of products/components and/or systems that meet desired safety, economic and performance criteria.
10. The ability to function on multi-disciplinary teams and exercise leadership to
accomplish project goals.

11. The ability to communicate effectively through written technical papers and/or project reports.

12. The ability to make effective oral presentations and convey technical material to an audience.

13. An understanding of professional and ethical responsibility and a broad education to appreciate the impact of engineering solutions in the societal context.

14. Recognition of the need for and an ability to engage in “life-long” learning.

15. An appreciation for and knowledge of diverse cultures and demonstrated proficiency in a foreign language.

8. Finally, what additional information would you like to share with the Senate Committee on Instructional Program Priorities regarding the program’s desired learning outcomes and assessment of their accomplishment?

[Please limit your response to 200 words or less]

We have successfully received ABET accreditation in 2009, 2003 1997, and 1991. We look forward to continuing to successfully achieve ABET accreditation in the future.